THE EFFECTS OF CUEING STRATEGY, LEVEL OF INFORMATION, AND MOTION CONDITION ON CHILDREN'S INTERPRETATION OF IMPLIED MOTION IN PICTURES

By

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This dissertation is dedicated to my parents,

Francis and Bernice Downs

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The purpose of this study was to determine the differences between kindergarten and 3rd-grade children relating to their abilities to interpret implied motion in two-dimensional representations when the motion conditions and the level of visual information included in the background are varied. In addition, a cueing strategy was utilized to determine the effectiveness of directing attention to the specific motion information.

Data were collected on 36 kindergarten subjects and 36 third-grade subjects. Each subject responded to examples of all of the types of motion conditions, levels of information, and the cueing strategy. The visuals used in the study were black-line drawings of animals in three different conditions of motion. Each of these conditions of motion was represented with no background information and also with additional background information in the visual. Those visuals that contained the additional background information were also used with a highlighting technique as a cueing strategy for directing attention.

The design of the study was a 2x3x3x3 split-plot factorial design with repeated measures. A repeated measures analysis of variance was used to analyze the data. The results of the analysis revealed significant differences ($p<.05$) for the effects of grade level, type of motion cue, and level of information presented. The 3rd-grade children were more consistent in their interpretations of implied motion in two-dimensional representations than the kindergarten children. Postural cues were more likely to denote motion than flow lines for both kindergarten and 3rd-grade children. The addition of information in a visual tends to decrease the ability to attend to implied motion cues for both kindergarten and 3rd-grade children. A cueing strategy is an effective method of directing attention to those cues utilized in two-dimensional representations to imply motion.

CHAPTER 1
INTRODUCTION

Because the majority of formal education occurs in classroom settings, educators often rely on visual representations of real world objects, scenes, or events for instruction. As Dwyer (1978) has stated, "The use of visualized materials (drawings, photographs, film, television, transparencies, charts, computer-assisted instruction, programmed instruction, etc.) to complement regular classroom instruction has become a common instructional technique at all levels of education" (p. xiii). Although the methods of delivering these visualized materials may differ from one medium to another, the message content may contain many of the same attributes. Because of these shared attributes, theorists in educational media have begun to focus on the design of the instructional messages that are being sent to the learners as well as the method of delivery (Fleming & Levie, 1978). One aspect of messages consists of the symbols that have been employed to communicate the intended information. Salomon (1979) has argued that "media's symbol systems are the primary, most essential attributes of media" (p. 3). Theorists in the field of educational media have recognized the need to focus research attention on the symbols that are incorporated into the design of instructional messages (Clark, 1983; Fleming & Levie, 1978; Salomon, 1979; Winn, 1984).

Statement of the Problem

The field of perception theory as it relates to picture perception is in its foundational stages. Theorists from many diverse disciplines have conducted isolated studies without regard to information available from other areas (Levie, 1987).

Pictures are used at every level of education for instructional purposes (Dwyer, 1978). Visual illustrations are regularly included in various educational media formats. Two-dimensional still visuals are utilized in textbooks, slides, filmstrips, overhead transparencies, charts, photographs, and computer programs. However, due to the lack of synthesis within the area of picture perception, educators do not have clear recommendations for including pictures as an instructional tool.

Within the current body of literature on pictures, one of the pervasive controversies centers on the issue of picture interpretation as a developmental acquisition. For many years, it was assumed that learning from pictures did not require any special skills on the part of the learner. In recent years, theorists and researchers have begun to challenge the concept that humans are born with an innate ability to interpret pictures. The present study is designed to determine whether children of different age groups attend to certain features in a picture when the level of information in the pictures is varied. In addition, the present study is designed to study the effect of a cueing strategy in directing children's attention to specific aspects of a visual.

Need for the Study

The controversies over the research in the field of educational media have been identified repeatedly in the literature (Allen, 1971; Clark, 1983; Saettler, 1968; Salomon, 1979). Many theorists have supported the contention that media studies that rely on comparing one form of media against another are replete with problems (Allen, 1971; Clark, 1983; Salomon, 1979; Winn, 1984).

One of the more outspoken critics of media research, Richard Clark (1983), cites the basis for the flaws in past media research. Clark has stated that "the best current evidence is that media are MERE VEHICLES that deliver instruction but do not influence student achievement any more than the truck that delivers groceries causes changes in nutrition" (p. 445). As Winn (1987) has observed, Clark's statement is a reaction to the types of research that have been conducted in the field of educational media. Media research has been brought under scrutiny due to the focus by past researchers on comparing one form of media against another form of media. These gross media comparison studies often resulted in confounded findings (Clark, 1987).

As a result of the lack of significance in many previous media studies, researchers have begun to focus on attributes of the message that is being sent to the learner as opposed to studying the vehicle that is delivering the message. In acknowledging the limitations of comparing one medium against another, Salomon (1979) has stated that "something within the mediated stimulus, possibly shared to some extent with other media, makes the presented information more comprehensible or better memorized by learners of particular characteristics" (pp. 5-6). Based on the need to analyze the messages being sent, Salomon has suggested that researchers focus on the various symbols used in the design of educational messages. Salomon has defined symbols as "most objects, marks, events, models, or pictures that can serve as bearers of extractable knowledge" (p. 29).

The theory of symbol systems is perhaps best described by Goodman (1968). Goodman's theory of symbol systems has provided a foundation for the study of pictures. In analyzing Goodman's theory of symbol systems, Salomon (1979) has noted that "of particular interest is the question of resemblance, similarity, or iconicity in symbolic representation, an issue that figures prominently in the treatment of educational media" (p. 29). Resemblance and similarity can be regarded as key issues in analyzing the portrayal of motion in two-dimensional representations.

The research in the area of pictures has been conducted by theorists in differing disciplines. It has included areas of memory, part-whole recognition, selective attention, and the effects of including pictures with text. Each of these areas has provided theorists with some insight into the processes by which humans perceive and gather meaning from pictures. However, the variance of backgrounds of theorists conducting this research has caused Levie (1987) to state that "it is clear that 'research on pictures' is not a coherent field of inquiry. Thus, most picture research is embedded within separate areas usually identified by the mental processes evoked by stimuli rather than by surface-level features of the stimuli themselves" (p. 26). It is the need to analyze the effect of these processes on the interpretation of these surface-level features that forms the basis for this study.

The research on children and pictures has focused on the mental operations evoked by certain stimuli. "Relatively little research has been done to determine how children come to comprehend pictures" (Sigel, 1978, p. 97). Theorists from various backgrounds differ in response to this issue. There are those theorists who contend that some components of picture interpretation are skills that cannot be achieved until a certain level of development is reached (Saiet, 1979). Others believe that no skills are necessary to interpret pictures, provided that the information contained in the light arrays of a picture are similar to the information contained in the light arrays of the real world (Gibson, 1971). The property of visual correspondence to objects in the real world is known as fidelity. Travers and Alvarado (1970) have stated that "a picture has fidelity to the degree to which the sheaf of light reflected by it and coming to a point where it is received by the eye corresponds in optical properties to the sheaf of light derived from the scene that the picture is designed to depict" (p. 48). Different types of pictures contain different levels of fidelity. However, "in the case of pictures, derived by a process other than the photographic, there is generally a considerable lack of fidelity" (Travers & Alvarado, 1970, p. 48).

Background of the Study

Researchers have studied the differences in abilities of subjects of different age levels to interpret implied motion in two-dimensional representations. Amen (1941) found "an increase with age of the tendency to interpret picture content in terms of activity, rather than in terms of static form" (p. 365). Bernard (1978/1979) and Saiet (1979) concluded that there was a significant effect on an individual's ability to interpret the artistic cues or symbols used to indicate motion in drawings and photographs due to level of cognitive development. However, Bernard (1978/1979) cautioned interpretations of the results of his study due to possible confounding of age and developmental level. The subjects in Bernard's study were in the 1st and 2nd grades. Developmental level was determined by the results of the Purdue Conservation Test. Due to the limited differences in ages in Bernard's study, subjects may have overlapped in developmental levels.

Friedman and Stevenson (1975) found a significant difference among subjects of different age groups in their abilities to interpret motion cues in two-dimensional representations. Friedman and

Stevenson concluded that the differences in ability to interpret motion cues among subjects of different age levels was due to the different types of motion cues used in the study. Friedman and Stevenson (1975) stated that "there is a relationship between the ease with which a picture is interpreted and the degree to which the picture retains the structure of the object, scene, or event it represents" (p. 778).

In an initial study to determine which types of cues are most consistently interpreted by young children, Downs (1988) noted that children do interpret various types of motion cues. However, they do not do so consistently. During interviews, children indicated an understanding that the various types of marks used for motion cues and the postural cue are used to indicate motion. However, children do not use these cues with repeated success.

The materials for the study consisted of 26 black-line drawings. The subjects of the drawings consisted of human figures as well as objects. The human figure drawings were black sillhouettes of full human figures. The human figures were portrayed as still or moving using flow lines, vibration marks, postural cues, postural cues with vibration marks, or postural cues with flow lines. The objects represented two types of classifications: inanimate and animate. The objects were chosen based on a survey of the types of objects typically portrayed in 1st-grade textbooks. The types of inanimate objects portrayed as moving in children's textbooks include skates, boxes, hammers, and stars. The animate subjects included a horse, butterfly, dog, duck, and penguin. As with the human figure pictures, the animate and inanimate objects had a representation in each of the following types of movement cues: still (no motion cue), flow lines, vibration marks, postural cues, postural cues with vibration marks, or postural cues with flow lines. The pictures were drawn as black-line representations on white paper.

The subjects consisted of six children attending a university laboratory preschool and research center. The subjects, five females and one male, were chosen on the basis of age and parental consent. The subjects were comprised of the older students at the laboratory school, four of whom were in their last summer of preschool.

Each of the subjects was taken individually into a private conference room. The child was then presented with one picture at a time. As the child looked at the picture, he/she was asked, "What do you see in this picture?" If the child responded by only naming the object in the picture, he/she was asked, "What can you tell me about the (object that the subject named) in the picture?" On occasion, as the subject responded that the object or human figure was moving, the subject would be asked, "How do you know that the ___ is moving." Of the five subjects who were asked that question, all of them responded by identifying the appropriate motion cue that had been used to indicate motion in that representation. Responses included "cause his foot is in back of him" (postural cue), "cause of these little lines" (vibration marks), "he's putting his feet up and down, up and down" (postural cue), "cause one leg's here and one leg's there" (postural cue), "because of these lines" (flow lines). These children were able to correctly identify postural cues, vibration marks, and flow lines as representing motion. However, they did not regularly utilize the motion cue information as they were viewing the pictures.

The results of this initial interview indicate that young children seem to understand the meaning of the implied motion cues. However, they do not use them consistently when describing what is occurring in a pictured scene. Researchers (Bernard, 1978/1979; Friedman & Stevenson, 1975; Saiet, 1979) have concluded that the interpretation of implied motion cues is a developmental acquisition. However, if a child can interpret a motion cue at one time, but not repeat the performance in the same setting with similar types of visuals, it is possible that something else is interacting with the child to prevent the continuous association of these cues and motion.

The literature on interpretation of implied motion cues ignores the visual perceptual aspect of selective attention. According to the research on selective attention, there is a developmental difference in children's abilities to selectively direct visual attention to one area of a visual. Selective attention refers to the process of directing one's awareness to a specific stimuli and ignoring the other existing stimuli within the environment (Moray, 1970).

Researchers have found that children's abilities to selectively attend to specific aspects of a visual is a skill that improves with age (Barrett & Shepp, 1988; Chapman, 1981; Day, 1978; Day & Stone, 1980; Enns & Cameron, 1987; Enns & Girgus, 1985; Lorch & Horn, 1986; Mackworth & Bruner, 1970; Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973; Shepp, Barrett, & Kolbet, 1987; and Smith & Kemler, 1977).

In addition to the developmental aspect of selective attention, researchers have found that the addition of irrelevant stimuli within a visual affects children's selective attention strategies (Barrett & Shepp, 1988; Day & Stone, 1980; Enns & Cameron, 1987; Lorch & Horn, 1986; Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973; and Smith, Kemler, & Aronfreed, 1975). Lane and Pearson (1982) have stated that developmental differences in selective attention "could result from a tendency by young children to use up some of their attentional capacity in the processing of irrelevant information" (p. 318).

Various cueing strategies have been identified in the literature as methods for focusing attention (Dwyer, 1978). Dwyer (1978) has defined cueing as "the process of focusing learner attention on individual stimuli within the illustration to make the essential learning characteristics distinct from other stimuli" (p. 158). The research on attention-directing cues includes the effect of labeling (Dusek, 1978), and color and form (Day, 1978; Miller, 1978) and the use of arrows (Rosonke, 1974/1975) to cue visual attention to relevant information. Dusek (1978) found that labeling facilitates central learning. Miller (1978) and Day (1978) concluded that color is a more effective cueing strategy than form. Rosonke (1974/1975) concluded that pointers were an effective means of directing attention in visuals with 1st-grade children.

Although "very few still pictures, such as are found in school textbooks, are designed to show a still scene" (Travers & Alvarado, 1970, p. 49), the existing research on interpretation of implied motion cues has left open the question of whether visual selective attention influences children's abilities to interpret these cues. As a result, no conclusions can be made in regard to children's abilities to interpret the dynamic properties of a picture that are used to convey motion. Travers and Alvarado (1970) have stated,

> Of considerable interest to those concerned with the design of educational materials is the matter of when children become capable of interpreting the dynamic properties of pictures, for until a child can do this there is little value in presenting him with most of the pictorial materials that are introduced into his education. (p. 52)

Purpose of the Study

This study was designed to determine if there are differences between children of two age groups in their abilities to attend to the dynamic property of motion in two-dimensional representations due to the effect of types of motion cue. In addition, information was added to the two-dimensional representations to determine if the addition of information would affect children's abilities to attend to the motion cues. A visual highlight was incorporated in the presentation of two-dimensional representations to determine if cueing children's visual attention would affect their abilities to interpret implied motion cues.

Research Questions

The following research questions were addressed in this study:

1. Is there a significant difference between kindergarten children and 3rd-grade children in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied?
2. Is there a significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied?
3. Is there a significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied due to an interaction effect of grade level and experimental group?
4. Is there a significant difference in children in their abilities to visually attend to three types of motion

conditions in two-dimensional representations due to the level of information in the visual?

5. Is there a significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and grade level?

6. Is there a significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and experimental group?

7. Is there a significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to the type of motion condition used?

8. Is there a significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition and grade level?

9. Is there a significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition used in the visual and group?

10. Is there a significant difference in children in their abilities to interpret motion in two-dimensional representations due to the interaction of level of information contained in the visual and type of motion condition contained in the visual?

Delimitations of the Study

This study was conducted with certain delimitations. The present study was limited to kindergarten and 3rd-grade students from three kindergarten classes and three 3rd-grade classes. Only those students whose parents signed a consent form were included in the study. Only those students who agreed to participate were included in the study. Those students who had been identified as having a learning disability were not be included in the study.

Limitations of the Study

This study contained limitations that affect the generalizability of the results. Those children who have witnessed actual movement of the types of animals represented in the pictures would be more likely to recognize motion in two-dimensional still pictures of animals. Therefore, those children who have seen the types of animals selected for the drawings in this research exhibiting motion, in either in a real world encounter or through film or video, would have an advantage over those children who have not seen these animals in motion.

The pictures used in this study were black-line drawings of animals. Therefore, the results of this study are generalizable to situations involving similar stimuli.

Definition of Terms

Flow lines are defined as evenly spaced parallel lines that extend horizontally from the trailing edge of the object that is supposed to be moving (Saiet, 1979).

Motion condition refers to the absence or presence of implied motion in two-dimensional visuals. The absence of implied motion in this study is conveyed by portraying animals in a still condition in which no postural cues or flow lines are used to portray motion. The condition of implied motion is conveyed by postural cues or flow lines.

Motion cues are various conventions that artists use in two-dimensional static representations to simulate movement or action. These cues include action or postural pose, multiple images, vibration marks, blurs, and flow lines (Friedman & Stevenson, 1975).

Pictures are any two-dimensional representations designed by someone for the purpose of communicating a message.

Postural cue refers to the representation of a figure in a profile in which the body and limbs are positioned in a manner that suggests the figure is moving as opposed to representing a figure in a vertical standing position (Saiet, 1979).

Selective attention refers to accepting a specific stimuli to respond to and ignoring the other stimuli within the environment (Moray, 1970).

Summary

Research in the field of educational media should explore the specific attributes contained within the various symbol systems utilized in different media formats. The purpose of the present study was to incorporate results of studies in the area of selective attention with children's abilities to attend to the specific quality of implied motion in two-dimensional visuals. A description of the problem and a need for the study were presented in this chapter. Also included in this chapter were a synthesis of the related literature and the research questions that would be addressed in this study. In addition, certain definitions, limitations, and delimitations of the study were identified.

Chapter 2 contains a review of the literature which provides a theoretical background in those areas related to picture perception. Chapter 2 also contains a review of the research related to children's interpretation of implied motion cues, the effect of added visual information on selective attention, and the use of cueing strategies to direct children's visual attention. The methodology and procedures are described in Chapter 3. A description of the visual stimuli and the design of the study are included in Chapter 3. The results of the study are presented in

Chapter 4. Chapter 5 contains the findings, discussion, implications, recommendations for future studies. and a summary of the study.

CHAPTER 2
REVIEW OF THE RELATED LITERATURE

Perception

Humans are constantly presented with stimuli within the environment. As humans encounter and interpret the stimuli within the environment, they change their behavior in accordance with their interpretation of the events and objects that surround them (Murch, 1973). "Perception, functionally speaking is the process by which we obtain firsthand information about the world around us" (Gibson, 1969, p. 3).

Dember and Warm (1979) have identified the perceptual system as "one which relates input to output, a system which receives various kinds of sensory input, processes this input, and thereby leads to the production of a particular response" (p. 6). Dember and Warm have defined human perception as "a process whereby stimulus information is elaborated and interpreted so as to yield organization and meaning" (p. 6). Perception requires the brain to encode sensory information (Murch, 1973).

Murch (1973) has defined the terms stimulus and response as these terms relate to perception. He has stated, "Any object or event which elicits a response can be considered as a stimulus for that response" (p. 2). Thus, an object is a stimulus only as it relates to a specific response. Dember and Warm (1979) have stated that perceptual activity occurs within the interrelated conditions of other activities. Therefore, "perception is relativistic rather than absolute" (p. 10). Further, the reaction to any given stimulus is based on the interpreter's experiences, which results in the process of perception being a subjective experience (Murch, 1973).

Visual Perception

There are five channels through which information from the environment can be obtained: vision, audition, gustation, olfaction, and tactile-kinesis (Murch, 1973). Of these senses, the visual channel provides the most information about the environment (Murch). The visual perceptual system allows for complex interaction with the environment (Bartley, 1980). The eyes have provided organisms with the means of orienting themselves to the environment (Sless, 1981). "Through the visual perceptual system we are aware of a whole space domain that entirely surrounds us" (Bartley, 1980, p. 144).

Visual perception is dependent on photic radiation within the environment. Photic radiation is the energy source that stimulates the eye; it is seen by the eye as light (Bartley, 1980). As light is reflected by objects, it provides information about the shape, texture, and color of objects (Murch, 1973).

Reflected light rays enter the eye and pass through the cornea and aqueous humor to the inner eye through the pupil. The pupil regulates the amount of light that is allowed to enter. The lens focuses the light beam on the light sensitive cells in the retina.

These light sensitive cells react to photons by translating the "input into nerve impulses which are transmitted up the optic nerve, through several substructures, to the visual cortex of the brain" (Murch, 1973, p. 12).

Theories of Visual Perception

Beyond a description of the physical activity of visual perception, many theories exist to explain how the brain interprets information provided by the eyes. Hagen (1980b) has described three major theories of visual perception: the Constructivist, the Gestaltist, and the Gibsonian.

The Constructivists believe that perception occurs as a result of hypothesis testing. The term Constructivist refers to the belief that the organism constructs meaning from unstructured stimuli and indistinct information (Hagen, 1980b). Hagen has stated that the Constructivists "argue that perception consists of adding meaning by correlation or association to a constantly varying and essentially unstructured visual stimulus in a process of probabilistic inference" (p. 4). Therefore, conscious perception results after unconscious processing of inference (Kennedy, 1974).

The Gestaltist theory of visual perception is based on Gestalt psychology which emphasizes the discrimination of part to whole. The Gestaltists concur with the Constructivist belief that the fundamental component of perception is that of providing meaning to unstructured stimulus (Hagen, 1980b). However, while the Constructivists argue that this occurs through a process of probabilistic inference, the Gestaltists believe that perception is a process of deterministic inference (Hagen, 1980b). The focus of the development of Gestalt theory of perception has been to determine the laws of organization that guide the sensory input into processing complete units rather than separate stimuli (Murch, 1973). According to the Gestaltists, "The whole is greater than or different from the sum of its parts so the study of perception is more properly the study of the laws of organization than the association of sensations" (Hagen, 1980b, p. 10).

The Gibsonian theory is based on the work of J.J. Gibson, who has proposed that the information available to a living organism is based on the structure of the environment and the light that is present (Rosinski, 1977). While the Gibsonians believe that perception is a process of deteministic inference, they propose that "perception consists of picking up meaningful structure in the light" (Hagen, 1980b, p. 4). Specifically, "there is some correspondence between the structure of the environment and the structure of the light that is available to our eyes" (Rosinski, 1977, p. 3).

Pictures

Pictures have been defined in various terms (Deregowski, 1980; Gibson, 1971; Goodman, 1968; Knowlton, 1966; Sigel, 1978). The treatment of the concept of picture has varied as well as the terminology associated with different theorists' definitions. For example, Gibson has defined pictures based on the terminology associated with his ecological theory of perception, while Knowlton has defined pictures using sign theory terminology. The definitions of Deregowski, Gibson, Goodman, Knowlton, and Sigel have provided various theoretical bases for much of the discussion of pictures in the literature.

Deregowski (1980) has defined a picture as "any surface pattern which is such that it evokes an ambiguous percept, the ambiguity resulting from the mutually exclusive notion of the pattern as it stands and of the pattern as a representation of an object" (p. 97). Deregowski has stated that a pattern can only be defined as a picture if the pattern is interpreted by the perceiver as a picture. Whatever the perceiver "defines as a picture is a picture" (Deregowski, 1980, p. 97).

Gibson (1971) has defined a picture in terms of the resemblance of the information provided by a light source of the pictured object to the object as seen in the three-dimensional world. He has identified a picture as "a surface so treated that a delimited optic array to a point of observation is made available which contains the same kind of information that is found in the ambient optic arrays of an ordinary environment" (p. 84).

Goodman has defined pictures based on his theory of symbols. "A symbol system consists of a symbol scheme correlated with a field of reference" (Goodman, 1968, p. 143). A symbol scheme is composed of characters and rules or modes for combining the characters to form other characters. Within a symbol scheme, Goodman identifies the existence of atomic and compound inscriptions. An atomic inscription is the smallest mark in that no other inscriptions are contained within an atomic inscription. A compound inscription contains more than one atomic mark. Tucker (1984/1985) has used Goodman's theory of symbols to define pictures as symbol schemes which (a) denote or label objects and object attributes in the real world, and (b) exemplify and possess attributes which belong to the same categories as attributes of real world objects denoted by the pictures.

Knowlton (1966) has classified pictures as iconic sign vehicles. Knowlton has further defined iconic sign vehicles by stating the following conditions:

> (a) that the iconicity of a sign must be determined with reference to the criterial attributes that are common to [the] sign vehicle and an exemplar of the sign's referent category, and (b) that the degree of criteriality of attributes is partly dependent on the interpreter of the vehicle. Thus, of all the potentially criterial attributes that might be shared by a sign vehicle and an exemplar of its referent, only a part might be used by the producer of a sign vehicle, and only a part of this part, by the interpreter of it. (p. 165)

Knowlton (1966) has identified three aspects or parts of a visual-iconic representation: the elements, the pattern of arrangement of the elements, and the order of connection of the elements. Knowlton has stated that a visual representation is iconic "if at least one of its three categories of 'parts'--elements, spatial arrangement of elements, or order of connection of elements--is nonarbitrary" (p. 175).

Sigel (1978) has defined a picture as any two-dimensional representation. He has identified three ways in which pictures vary: in the detail presented, in the representational level, and in spatial perspective. The amount of detail presented refers to the number of elements used in a picture. An example of the range of detail presented is "the detailed portrait as opposed to a sketch or outline" (p. 94). The representational level is the degree to which the picture approximates the object or event that is being illustrated. Spatial perspective refers to the representation of the object as flat or as implying three-dimensional perspective.

Types of Pictures

Pictures can be classified in various ways. Deregowski (1980) and Knowlton (1966) have provided two different classifications of pictures.

Deregowski (1980) has identified a scale for classifying pictures, based on the depth cues that are present in the representation. On this basis, pictures can be classified on a continuum ranging from epitomic to eidolic. Epitomic pictures "epitomize the concepts of particular objects although they do not evoke perception of depth, an attribute which objects obviously have" (p. 98). Examples of epitomic pictures are silhouettes and Rorschach inkblots. Eidolic pictures contain pictorial depth but do not contain "clearly attributable characteristics associated with real objects" (p. 98). Epitomic pictures and eidolic pictures are the extremes in pictorial representations. Deregowski (1980) has stated that "most pictures contain both epitomic and eidolic elements" (p. 98).

Knowlton (1966) has identified three types of pictures: realistic, analogical, and logical. A picture "is a realistic picture provided that the communicator's intent is to make reference to the type of object portrayed" (Knowlton, 1966, p. 176). As Knowlton has stated, this category is the most obvious "because it includes pictures in the vernacular sense" (p. 176). Thus, when an aspect of the real world is perceivable through the visual modality and is depicted visually, it is a realistic picture (Knowlton).

Analogical pictures represent either the phenomenal or nonphenomenal world through the visual phenomenal world. Knowlton (1966) has provided a rationale for the use of analogical pictures by stating the following:

> This sort of representation would seem of potentially greatest value when, for whatever reason, some X-state of affairs is nonphenomenal; for instance, because X has no tangible existence, or because it is too small, too large, too distant, too transient to be recorded by aided or unaided eye. (p. 177)

Knowlton (1966) has identified three types of logical pictures. In the first type of logical picture, schematization is used to represent various elements. Two examples of this are circuit schematic representations and road maps. In both of these examples arbitrary pictorial elements are used to signify relationships that are isomorphic with the real world elements being depicted. A second case of logical pictures occurs when visual traits are given to something that exists in a certain form but cannot be seen in that form. Knowlton uses the concept of an atom as an example of the second type of logical picture. Although physicists use visuals to describe the structure of an atom, it is not assumed that the visual representations actually look like atoms. Thus, although atoms do exist, they do not exist in the manner in which they are visually portrayed. The third type of logical picture is a visualization of an idea; the referent of the visual does not exist in any tangible form.

The classification of pictures based on Knowlton's (1966) taxonomy is based on the function or purpose for which the visual is being used. As Knowlton has stated, "It is not possible to categorize visual-iconic representations independently of the textual context in which they are embedded" (p. 180).

Picture Perception

The perception of objects, representations, and symbols requires different skills than the processes involved in spatial perception within the environment (Rosinski, 1977). Humans must not only be able to locate something in the environment, they must also be able to identify it (Rosinski, 1977). Knowledge about "the external world evolves through active engagement and subsequent 'construction' of the external into 'mental' representations (Sigel, 1978). This task is more difficult when the identification depends on a two-dimensional representation. As Sigel has stated, "In view of the fact that 'reality' cannot be depicted in a true copy, all pictures are approximations of that reality, depicting aspects defined by the constructor of the picture" (p. 107). Therefore, the perception of pictures has been identified as a special case of visual perception (Hagen, 1980a; Rosinski, 1977).

As humans employ the sense of vision to gain meaning from the environment, a unique perceptual situation is found in gaining meaning from pictures. Pictures have a dual reality. As Gregory has stated, "Drawings, paintings, and photographs are objects in their own right--patterns on a flat sheet--and at the same time entirely different objects to the eye" (1970, p. 32). The ability to interpret information about the three-dimensional world from two-dimensional representations gives humans the opportunity to encounter and respond to that which is not in the immediate and present environment (Gregory, 1973). Because of the dual reality involved, viewing pictures requires a skill on the part of the observer. As Sigel has stated, "Pictures, as complex stimuli, demand a set of cognitive processes that enable the viewer to comprehend the paradox and respond appropriately" (1978, p. 96)

Rosinski (1977) has stated that "much of our perceptual experience involves pictures rather than actual things" (p. 170). Rosinski has identified two major theoretical approaches to pictorial perception; the communications theory of perception and the surrogate theory of pictorial perception.

The surrogate theory of picture perception is based on the belief that pictures provide stimulus information that transmits the same information in light arrays as the referent does in the environment. Rosinski (1977) has identified Gibson's theory of ecological perception as a surrogate theory of pictorial perception.

Gibson (1980) has stated that the perception of markings on a surface is different from the perception of a surface. Further, Gibson has stated that "the properties of surfaces are not the same as the properties of marks on a surface" (1980 p. xi). Gibson has pointed out the following differences between surfaces and marks on a surface:

1. Marks on a surface can have a referential meaning; that is, marks on a surface can be a surrogate for something else.
2. A surface has a texture but it is not a substitute for something else.
3. While all animals perceive surfaces, only human animals are capable of making and perceiving pictures and symbols.
4. There is a duality to the surface of a picture; it is in and of itself a surface as well as a series of markings on a surface.
5. Surfaces can be decorated without having any referential meaning.
6. Surfaces can acquire dirt. Again, this does not provide the surface with any referential meaning.

7. The meaning of surfaces, substances, layouts, and events are perceived in the course of development through the process of maturation and learning by encountering the surfaces in the environment without schooling. Surface markings require learning, as merely encountering surface markings is not sufficient to comprehend the meanings being communicated.
8. Surfaces are perceived. Pictured surfaces are not perceived in the same sense.

Gibson has summarized the differences between surfaces and markings on surfaces by stating that "a surface of the environment has its own characteristic texture" (1980, p. xiv). When a surface is treated so that it contains information about something other than the surface, it provides the observer with a unique experience.

Proponents of the communications theory of perception treat pictures as a system of signs and symbols. The emphasis is focused on the "interpretive and communicative aspects of graphic displays" (Rosinski, 1977, p. 171). Goodman's theory of symbols exemplifies the basis of this approach to pictorial perception. Hagen (1980b) has identified this approach as the Constructivist approach to pictorial information. According to Hagen, the Constructivists argue that pictures are composed of an arbitrary code which in turn must be read by the person viewing the picture. Given this context, "perceiving and understanding a picture can be considered in the same way as understanding a language" (Rosinski, 1977, p. 170). Rosinski has stated:

> Just as we must learn the arbitrary meanings that are assigned to sounds in language (semantics) and the organization of those sounds into meaningful sentences (syntax), so must the semantics and syntax of pictures and graphic design be learned. The development of pictorial perception, then, would consist of learning to interpret a visual display in ways that are consistent with cultural norms. (pp. 170-171)

To give meaning to the concept of pictures as having semantics and syntax, picture perception can be described as a system of signs and symbols (Rosinski, 1977). A symbol is any object, movement, gesture, mark, or event that represents something other than the object, movement, gesture, mark, or event itself (Salomon, 1979). Salomon has defined symbols that are used to communicate information as "most objects, marks, events, models, or pictures that can serve as bearers of extractable knowledge" (p. 29). Symbols function as characters with rules that provide methods of combining the individual characters into symbol schemes (Goodman, 1968; Salomon, 1979). The mode of combining symbols into schemes differs from scheme to scheme (Salomon). Salomon has stated that "in most symbol schemes, the characters, or single (atomic) elements, can be combined in particular lawful or conventional ways to create compound elements" (p. 30). The alphabet is a symbol scheme in which each letter is an atomic character that can be combined with other atomic characters to form compound elements of words and passages (Salomon, 1979).

"A symbol system consists of a symbol scheme correlated with a field of reference" (Goodman, 1968, p. 143). Salomon (1979) has provided the following examples of symbol systems:

> Musical performance is the field of reference for musical notation; dance movements are the field of reference for labonotation or dance notation; objects are the field of reference for photographs; sound events or pronunciations are the field of reference for the alphabetic notation. (p. 31)

Knowlton (1966) has identified the superordinate category of sign to include various types of representations. Knowlton has defined a sign as being a substitute stimulus. He has further classified the concept of sign by stating that those signs that are "produced by someone with the (purposeful) intent to communicate are signs that classify as symbols" (p. 158).

All symbols have referents; that is, all symbols attempt to direct the viewer's behavior in the absence of something else (Knowlton, 1966). The referent, therefore, is the stimulus that is unavailable or missing at the point in time that the viewer relies on the symbol. Referents are grouped into categories (Knowlton). A referent category refers to a collection of things, processes, and ideas or feelings. Referent categories are determined by identifying attributes of the referent. These attributes provide a common basis for identifying the referent (Knowlton).

Signs can be presented to an individual through various sensory modes (Knowlton, 1966). For example, written words and spoken words can be used as substitute stimulus. The stimulus being presented might be recognized by the perceiver through either or both of these signs (Fleming & Levie, 1978). However, when using written words the perceiver generally relies on the visual modality while the perceiver usually relies on the auditory modality to perceive the spoken word. The various modes used for communicating signs are referred to as vehicles (Knowlton).

Knowlton (1966) has distinguished between two types of sign vehicles, digital signs and iconic signs. Digital sign vehicles do not resemble the referents for which they are substituting. Knowlton has identified words, numbers, flag signals, and the sign language of the deaf as examples of digital signs. In contrast, iconic sign vehicles resemble the criterial attributes of the referent. Based on this distinction, pictures classify as iconic sign vehicles.

Development of Picture Perception

The ability to judge depth or distance of an object provides living organisms with the knowledge of where something is located. In addition to this skill, it is necessary to be able to discriminate between visual stimuli so that the organism can determine what something is. Animals use this discrimination ability to distinguish between prey and predators (Rosinski, 1977). Humans use this ability to discriminate between objects. Humans also use this ability to distinguish characteristics of objects when they are represented pictorially or symbolically. Spatial perception is the ability to judge where something is in relation to the organism; pattern perception is the ability to distinguish what something is (Rosinski, 1977).

There are three aspects to pattern perception: discrimination, recognition, and identification. In reviewing the research that has been conducted to determine infants' abilities to perceive patterns, Rosinski has concluded that "infants possess the ability to distinguish between different patterns from birth" (Rosinski, 1977, p. 144). Pattern recognition begins during the first six months of life. By the age of 6 months, a crude form of classification as evidenced by stranger anxiety indicates the existence of pattern identification.

Although infants are capable of pattern discrimination, recognition, and identification, the perception of pictures is a specific type of pattern perception. Rosinski (1977) has stated that "the development of perceptual ability differs depending on the relationship between the pattern and its meaning" (p. 170). Although perceptual requirements differ in the unique case of picture perception, Sigel (1978) has stated, "Relatively little research has been done to determine how children come to comprehend pictures" (p. 97).

Children in many modern cultures are exposed to a variety of visual and pictorial stimuli (Olson, Yonas, & Cooper, 1980). Because of children's familiarity with visual stimuli, the assumption might be made that the development of pictorial perception does not differ from normal perception (Olson, Yonas, & Cooper, 1980). As Olson, Yonas, and Cooper have stated, "This would probably be true if the intended perception is only of the two-dimensional pattern on the picture surface, but the two-dimensional pattern on the picture plane usually stands for a three-dimensional spatial array" (1980, p. 156). Although it is generally accepted that most pictorially experienced adults are capable of making the transition from two-dimensions to three-dimensions, children do not possess spatial skills at the same level as adults (Olson, Yonas, & Cooper, 1980). Therefore, children do not gain as much information from pictures as adults (Travers & Alvarado, 1970).

Travers and Alvarado (1970) have suggested that limited capacity may be a foundational problem for young children in interpreting different sources of information within a picture. Travers and Alvarado have argued that "the young child's problem in dealing with pictorial material, even when it involves common scenes, stems from his limited capacity to handle simultaneously information from the different sources in the picture" (1970, p. 56). Travers and Alvarado have stated, "A minimum condition for receiving information from a picture is that the person involved attend to it" (p. 56).

Selective Attention

Within the environment, the human system is in constant exposure to input from a plethora of stimuli. Due to the limitations of the human system to process all available stimuli simultaneously, "the perceptual system must be highly selective" (Dember & Warm, 1979, p. 125).

In a general sense, attention means "that some one element of consciousness is picked out from the others, and given an advantage over them. It is more fully conscious, more adequately a part of our experience than are the others" (Pillsbury, 1973, p. 2). In this capacity, "the concept of attention is the focusing of awareness" (Dember & Warm, 1979, p. 125).

Due to the limitations of living organisms to process stimuli from the environment, some stimuli are attended to while other stimuli are disregarded (Murch, 1973). This process has been identified as selective attention. Selective attention has been defined as "the ability to attend voluntarily to some attributes of the stimulus array and to ignore other attributes" (Enns & Girgus, 1985, p. 319).

Broadbent (1958) has used the language of communication theory to describe the limitation of stimulus reception, the process of selective attention. Broadbent used the research on auditory perception to develop a theory to describe the processing of information through the nervous system. According to Broadbent, the processing of information can be described in terms of capacity, that is, "the limiting quantity of information which can be transmitted through a given channel in a given time" (p. 5). Broadbent stated that organisms utilize a selective filter to disregard irrelevant stimuli.

Broadbent (1958) developed the filter theory to describe how information enters the nervous system through multiple parallel channels. The "nervous system acts to some extent as a single communication channel, so that it is meaningful to regard it as having limited capacity" (Broadbent, p. 297). However, the quantity of information entering the nervous system, usually exceeds the capacity of the higher level perceptual analysis system, referred to as the P system in the filter theory. Because of the limitation of the nervous system, a selective process occurs. As Broadbent has stated, "A selective operation is performed upon the input to this channel, the operation taking the form of selecting information from all sensory events having some feature in common" (p. 297). "The selection is not completely random, and the probability of a particular class of events being selected is increased by certain properties of the events and by certain states of the organism" (Broadbent, p. 297). Therefore, the information from one of the input channels is allowed to transmit through the selective filter to the P system.

The location of the short term store at the end of the sensory input indicates that the organism can receive and store more than one message while another message is being sent through the filter. However, Broadbent (1958) has stated that the duration for these messages to remain in short-term store is very brief; "The maximum time of storage possible in this way is of the order of seconds" (p. 298). To elude the confines indicated by the limitations of the short term storage, "it is possible for information to return to temporary store after passage through the limited capacity channel: this provides storage of unlimited time at the cost of reducing the capacity of the channel still further and possibly to zero" (p. 298).

Development of Selective Attention

Lorch and Horn (1986) have stated that selective attention is "the efficient use of task-relevant information without disruption by irrelevancies" (p. 184). One of the consistent findings in the research on perceptual development is the trend for older children to be more successful at selectively attending to relevant stimuli than younger children. There are several views that have been proposed in the literature to explain the age differences associated with selective attention.

Mackworth and Bruner (1970) suggested that children and adults employ different eye movements when looking at pictures. Mackworth and Bruner studied children and adults to determine the differences in search strategies between children and adults when trying to identify pictures. The subjects in the Mackworth and Bruner study were undergraduate students and 6-year-old students.

By analyzing the eye movement patterns of the subjects, Mackworth and Bruner (1970) discovered differences in the picture search behavior of children and adults. The eye fixation times for children were slightly longer than those for adults.

Children focused their gaze when viewing very blurred pictures but did so with "little agreement between children on the areas they chose for such detailed concentration" as opposed to the adults for whom "the group visual concentration measures give a reasonable understanding of what most individuals are doing" (Mackworth & Bruner, 1970, p. 162). Regardless of whether or not subjects were trying to understand a picture, children concentrated less upon the informative areas of the picture than the adult subjects.

Addition of Visual Information

Lane and Pearson (1982) have stated that "the most common way in which the developmental aspects of attention have been studied involves the introduction of irrelevant stimuli into the experimental task" (p. 317). The research has included informing subjects as to what information is relevant (Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973) and the addition of visual distractors (Day & Stone, 1980; Smith, Kemler, & Aronfreed, 1975).

Pick, Christy, and Frankel (1972) have suggested that older children are better at ignoring irrelevant information than are younger children. Pick et al. (1972) designed a task to determine whether children's improvement in selective attention is a result of their ability to filter out irrelevant information or whether the improvement is due to an increase in the ability to disregard irrelevant information. The difference between these conditions is whether selective attention occurs before or after the stimulus event. The subjects for the experiment were 2nd-grade and 6th-grade students. The stimuli for the experiment were wooden animal shapes that varied in three characteristics: shape, color, and size.

Pick, Christy, and Frankel (1972) included a preinformed condition versus a postinformed condition to determine the timing of selective attention. In both conditions, the subjects were asked to judge the paired animals to determine whether they were the same on one of two aspects; either color or animal. Pick, Christy, and Frankel concluded that older children are more able to filter out irrelevant information than younger children.

In a follow-up experiment, Pick and Frankel (1973) designed a task to determine how general the developmental trend of filtering irrelevant information is and how the filtering works. In contrast to the previous experiment, Pick and Frankel used two-dimensional stimuli in the follow-up study. They used slide projections of the same stimuli used in the Pick, Christy, and Frankel (1972) experiment. Thus, in addition to questioning the generalizability and functioning of the developmental filtering, Pick and Frankel were also interested in the effect of two-dimensional representations versus three-dimensional objects.

The subjects in the Pick and Frankel (1973) experiment consisted of 2nd-grade students and 6th-grade students. The stimuli were pairs of wooden animals that had been photographed side by side and produced as 35-millimeter slides. The subjects were asked to make timed judgments based on shape and size. Two separate experimental conditions of preinformed and postinformed were conducted. In the preinformed condition, the experimenter said "size" or "animal" and simultaneously projected the images. In the postinformed condition, the slide was projected for one second then removed before the experimenter asked the subject to make a judgment on size or animal.

Pick and Frankel (1973) concluded that there is a general trend with age in the ability to ignore irrelevant information. In addition, the authors stated, "Older children make more effective use than do younger children of knowledge about what information is relevant for a task" (p. 355).

Smith, Kemler, and Aronfreed (1975) designed a study to determine whether young children's inability to selectively attend to tasks is a result of a lack of skill to separate incoming information. The subjects in the Smith et al. (1975) study consisted of students in each of three grade levels: kindergarten, 2nd grade, and 5th grade. The basic stimuli used in the baseline task were slides of black-line drawings of stick figures portrayed in positions indicating fighting, dancing, running, or standing. In addition to the basic stimuli of the baseline task, there were three distractor conditions presented. In the first condition, the distractor was an auditory stimulus. The visual stimuli of the black-line stick figures were presented at the same time as two audible tones. In the second distractor condition, the basic visual stimuli of the black-line drawings of the stick figures were used with a visual distractor of a border added to the black-line drawings. In the third condition, color was used as a distractor with the figures being drawn in color rather than black-line.

The 2nd-grade subjects were least distracted by the auditory distractor, experienced greater distraction with the border condition, and the most distraction with the color condition. Support of the separation hypothesis was found by comparing the 5th-grade subjects results with the 2nd-grade subjects.

> The difference in the effect of distraction between these developmental levels is greatest in the condition of least separation(color) and least in the condition of greatest separation (auditory). This trend conforms to the suggestion that developmental differences in selective attention are due in part to the younger child's greater difficulty in separating messages. (Smith, Kemler, & Aronfreed, 1975, pp. 359-360)

While the 2nd-grade and 5th-grade subjects were indicative of developmental differences in respect to separation, the kindergarten subjects presented data that were inconsistent with the separation hypothesis. The kindergarten subjects performed best on the color distraction, the condition with the least distraction. They were most distracted by the auditory condition which led Smith et al. (1975) to state that "older and younger subjects are solving this task in quite different ways" (p. 360).

Day and Stone (1980) examined 5-year-olds, 8-year-olds, and adults to determine the effects of perceptual set and visual noise on the identification of pictures. The subjects had to match a target picture to a standard picture. The stimuli for the experiment were simple line drawings of common objects. Subjects were asked to identify whether a standard and a target picture were the same or different. A second experimental condition consisted of visual noise or no visual noise. The visual noise condition was present when a series of six briefly exposed drawings preceded the presentation of the target picture. In the no noise condition, no extra visuals were presented. Day and Stone reported that the proportion of correct responses increased with age for both conditions of the set and target matching and the set and target not matching. In addition, the use of the set condition facilitated efficient perception. The presence of visual noise when using additional visuals decreased the accuracy of subjects of all ages when identifying the target in both the set and no set conditions. The children's accuracy was more affected by the presence of the visual noise than the adults' accuracy.

Researchers in the field of selective attention have studied the ability of children at different age levels to filter out irrelevant information when trying to attend to specific visual stimuli (Day & Stone, 1980; Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973; and Smith, Kemler, & Aronfreed, 1975). In addition, researchers (Barrett & Shepp, 1988; Enns & Cameron, 1987; Enns & Girgus, 1985; Lorch & Horn, 1986; Shepp, Barrett, & Kolbet, 1987; and Smith & Kemler, 1977) have studied the differences in abilities to perceive visual stimuli separately or integrally in children of different age groups.

Barrett and Shepp (1988) studied the effects of irrelevant variations within a visual stimulus on subjects of different age groups. The purpose of the study was to determine if irrelevant variations interfere with performance on a visual selective attention task.

The subjects for Barrett and Shepp's (1988) study were 2nd-grade students, 5th-grade students, and undergraduate college students. The task involved a combination of matching-to-sample and priming. The prime was the target visual that was initially presented to the subjects. The stimuli for the first experiment varied in form and color. The stimuli for the second experiment varied in form and the color variations only occurred as outlines around the geometric froms. The subjects were presented with a pair of stimuli to select the match of the prime. In different trials, the subjects were asked to attend to one condition (either form or color) and ignore the other. A reaction time measure was recorded for each trial.

Barrett and Shepp (1988) discovered that subjects from all age groups were more successful at perceiving the spatially separated features of color and form as used in the second experiment. The 2nd-grade children experienced more difficulty with the spatially integrated features of color and form that were used in the first experiment. Barrett and Shepp concluded that these results support "the view that there is a complicated relation between the nature of the stimuli, the demands of the task, and the age of the perceiver" (p. 395).

Smith and Kemler (1977) explored whether there were differences between young children and older children in their abilities to differentiate visual stimuli into relevant and irrelevant parts. Smith and Kemler conducted two experiments to test whether "young children perceive integrally some stimuli that older children perceive separably" (p. 279).

The subjects were kindergarten students, 2nd-grade students, and 5th-grade students. The stimuli were irregular quadrilateral forms which differed in size and brightness. Smith and Kemler (1977) utilized a free classification paradigm by asking students to select the two (from a group of three) that "'most go together'" (p. 284) in the first experiment. In the second experiment, the same stimuli were used but were presented to the subjects in groups of four with the instruction to "'make two groups'" (p. 290).

Smith and Kemler (1977) stated that there was a difference in children's abilities to perceive separably based on the age of the subjects. Smith and Kemler determined that kindergarten children integrated size and brightness while 5th-grade children separated the stimuli on those dimensions. The 2nd-grade students did not exhibit any clear results as their resulting data were more ambiguous than the data on the kindergarten and 5th-grade students.

Chapman (1981) studied the developmental trends in perceiving configural stimuli. Chapman defined configural stimuli as "stimuli composed of physically separate elements which are nevertheless perceived integrally as evidenced by interference when dimensions are combined orthogonally in a sorting task" (p. 334). Chapman chose line drawings of a human face as configural stimuli for his study because the mouth and eyes are physically separate but can be perceived as an overall expression.

Chapman (1981) conducted three experiments with 1st-grade and 4th-grade students. In each of the experiments subjects were asked to sort the drawings into piles based on eyes (opened or closed) or mouth (smiling or frowning). The 1st-grade subjects perceived the face as a configuration while 4th-grade subjects were able to discriminate the face as either a configural stimuli or as separate dimensions. He concluded that "the spacing, shapes, and orientation of stimulus elements as well as the subject's flexibility of attention determine whether the subjectively perceived stimulus is the configuration as a whole or its elements taken separately" (p. 347).

Enns and Girgus (1985) conducted research to determine the relation between developmental improvements in selective attention and the integrative aspects of visual attention. Enns and Girgus studied the focusing and spreading of visual attention in subjects from three age groups.

The subjects were 2nd-grade students, 4th-grade students, and university students. The stimuli for the first experiment were parentheses that were either curved right or curved left. The stimuli for the second experiment were arrows that were either facing left or facing right. The procedures in both experiments were the same. In the selection task, subjects were asked to identify the direction of one of the elements (the element placed on the left side of the stimuli). In the integration task, subjects were asked determine whether the direction of two elements was the same or whether the elements curved in different directions.

Enns and Girgus (1985) suggested two conclusions based on the results of their study. First, they stated that younger children are not as skilled as older children and adults at expanding and contracting the size of the area to which they are visually attending. Second, young children may only possess the ability to process configural properties of a stimulus that can be perceived in a single glance.

Shepp, Barrett, and Kolbet (1987) studied the developmental changes in selective attention. They designed tasks which involved spatially integrated or spatially separated dimensions. The subjects were kindergarten students, 2nd-grade students, and 5th-grade students. The stimuli for the experiments were cards containing colored disks with pointers inside of the disks. At the edge of each disk was an outer ring containing lines. A speeded classification paradigm was used with one dimension varied and one dimension held constant in each of the two studies.

Shepp, Barrett, and Kolbet (1987) found a difference among children of different age groups in their abilities to visually perceive structure. Kindergarten children perceived color and orientation as integral features while 5th-grade children appeared to analyze the specific features of stimuli. In addition, they stated that "when features are integral, the stimuli are perceived holistically, and it is presumably the nature of the perceived structure rather than any resource deficiency that leads to a failure of selective attention" (p. 176).

Lorch and Horn (1986) designed a study to determine if habituation of attention to irrelevant information effects the process of selective attention. In addition, the study was designed to determine if habituation to irrelvant stimuli was effected by the age of the subjects. The children were divided into two groups based on age. The younger group consisted of subjects in kindergarten, 1st grade, and 2nd grade. The older group was comprised of subjects in 4th grade, 5th grade, and 6th grade.

The habituation hypothesis in the Lorch and Horn (1986) study included two predictions:

> First, the critical prediction is that the group preexposed to stimuli irrelevant would experience less interference than would the other two groups. Second, interference would diminish across speeded classification trials, at least for the two groups not receiving preexposure to the irrelevant stimuli. (p. 186)

Three colored pictures were placed on a card. The pictures were either flowers, animals, or cartoon characters. After completing the preexposure condition, the subjects were asked to complete a speeded classification task. The stimuli in this task were decks of cards divided into three groups: a practice deck, a baseline deck, and an irrelevance deck. The practice deck had dots forming a matrix. The baseline deck contained a black-line outline of a square. The irrelevance deck contained black-line drawings of the squares used in the baseline deck with the addition of a colored field and an outline of a geometric shape surrounding the square.

Lorch and Horn (1986) found that preexposure to the irrelevant stimuli reduced interference in the task. This was true for all age children; however, the effect of the preexposure condition was greater for the younger children.

Enns and Cameron (1987) studied the relations between visual searching, filtering, and priming. They defined visual search as "the movement of attention in visual space" (p. 38). Filtering was described as "the ability to ignore irrelevant stimuli or attributes in the visual field while a task-relevant stimulus or attribute is processed" (p. 39). Priming was defined as "maintaining or changing cognitive strategies over time" (p. 39). In addition, they examined whether a relation existed between these tasks and the factor of age of the subjects.

The subjects consisted of preschool children, 1st-grade students, and university students. The stimuli for the experiment were either left or right pointing arrows. A fixation point was projected in the center of the screen prior to each of the trials.

Enns and Cameron (1987) discovered that improvements in each of the areas of visual search, filtering, and priming occurred with age of the subjects. In addition, they found that visual search was unrelated to the tasks of filtering and priming. However, the tasks of filtering and priming were related to each other.

Visual Cueing Strategies to Direct Attention

Dwyer (1978) has defined cueing as "the process of focusing learner attention on individual stimuli within the illustration to make the essential learning characteristics distinct from other stimuli" (p. 158). The research on attention-directing cues in two-dimensional static representations includes the effect of labeling (Dusek, 1978), color and form (Day, 1978; Miller, 1978) and the use of arrows and pointers (Rosonke, 1974/1975) to cue visual attention.

Dusek (1978) studied the effects of labeling and pointing on children's abilities to selectively attend to a central stimuli. The subjects in Dusek's research were 3rd-grade, 5th-grade, and 7th-grade students. The central stimuli were line drawings of animals and the incidental stimuli were line drawings of household objects.

Subjects were instructed to label or point to the central stimuli of each visual. Dusek (1978) found that the use of labeling increased central learning but pointing did not increase central learning. Dusek concluded that labeling is effective for focusing attention and for providing an encoding strategy.

Day (1978) designed a visual search task to determine the developmental changes in children's abilities to attend selectively to specific aspects of a visual display. The task involved having subjects of different age levels search a matrix to locate a target letter under eight search conditions.

The subjects in the study were in grades 1, 3, and 6. The visual displays were in the form of matrices of capital letters. The matrices differed by color and by shape. Three cueing conditions were: no cue, color cue, and shape cue. The cueing conditions were presented verbally to the subjects. Day (1978) found that subjects of all ages increased their accuracy when utilizing color cues. Shape cues were less effective than color cues.

Miller (1978) studied the effects of color and form on a visual selective attention task. The subjects in Miller's study were in the 2nd grade, 6th grade, and college. The stimuli were capital letters in a circle or square of two different colors. The eye movement and search time of the subjects were recorded as they performed a visual search task.

Miller (1978) found that the 2nd-grade subjects recorded higher search times when shape cues were utilized. Color cues were more effective for the 6th-grade students. The college students improved in search performance in all conditions except the square shape cue.

Rosonke (1974/1975) studied the effects of using arrows and a pointer in directing children's visual attention. The subjects in Rosonke's study were 1st-grade and 4th-grade students. The stimuli were overhead transparencies with audio-taped directions. The attention-directing strategies included an auditory cue and three visual cues of a small arrow, a large arrow, and a pointer.

Rosonke (1974/1975) found that for the older subjects, all cueing methods were effective for the task of locating certain portions of the drawings. For the 1st-grade subjects, the pointer was the most effective cueing strategy, while the arrows were more effective than the auditory cue.

Rosonke (1974/1975) concluded that visual and auditory attention directing devices are effective for 4th-grade subjects given the task of locating specific information in line drawings. Visual attention-directing strategies were more effective than auditory cues for the 1st-grade subjects.

Implied Motion in Two-Dimensional Representations

Because pictures are two-dimensional and static, there are certain aspects of the three-dimensional world that must be implied through the use of artistic conventions or cues. One such aspect of the three-dimensional world is that of movement. Because pictures are static, the concept of motion must be implied. Implied motion cues are devices incorporated in two-dimensional non-moving graphic representations to transmit the concept of movement to the perceiver (Saiet, 1979). The following conventions have been used to imply motion in two-dimensional static representations: postural cues, multiple images, vibration marks, flow lines, and blurs.

The postural cue or action pose refers to the representation of a figure in a profile in which the body and limbs are positioned in a manner that suggests the figure is moving as opposed to representing a figure in a vertical standing position (Saiet, 1979). Friedman and Stevenson (1975) have defined multiple images as a technique that uses the repeated drawings of the same part of the object that is supposed to be moving. Vibration marks are short lines which echo that part of the object that is supposed to be moving (Saiet, 1979). A blur is a shaded area extended from the trailing edge of the figure and is used to indicate great speed (Saiet). Flow lines are defined as evenly spaced parallel lines that extend horizontally from the trailing edge of the object that is supposed to be moving (Saiet).

Research With Children Utilizing Implied Motion Cues

Campbell (1976) tested 1st-grade children's abilities to interpret dynamic pictures used to convey mathematical concepts in textbooks. In testing which physical characteristics of pictures were most effective in communicating mathematical relationships to children, Campbell hypothesized that there would be no significant difference in a child's ability to interpret motion based on the use of realistic drawings and stylistic drawings. She also tested the effect of single line drawings, sequences of three line drawings, or a combination of sequence and single line drawings on a child's perception of motion. Finally, she tested to determine if there was a correlation between 1st-grade children's abilities to perceive motion within two-dimensional line drawings and their ability to state the mathematical relationships depicted by the drawings.

Campbell (1976) found that drawing style (realistic versus stylistic) did not have a significant effect on the perception of motion. She discovered that the use of single line drawings, sequences of three line drawings, or combinations of sequence and single line drawings did not affect the subjects' interpretations of motion. However, viewing sequences of pictures did have a positive effect on children's ability to perceive motion in single pictures. There was not a significant correlation between perception of motion in dynamic pictures and mathematical relationships depicted by the pictures. However, Campbell noted that "the data obtained in this study suggest that students who were unable to tell stories which revealed an adequate level of assimilation of the characteristics of the pictures were also unable to characterize the pictures by a number sentence" (p. 97).

In a subsequent study, Campbell (1979) investigated the effect of the type of motion cue (postural cue or artistic cue) and the number of pictures (single or sequence of three pictures) used to convey an event. The subjects in this study were 1st-grade children.

The results of this study indicated that sequences of pictures were more effective for conveying mathematical relationships to 1st-grade children than single pictures. Analysis of the data indicated that postural cues were more easily interpreted by 1st-grade children. However, the author stated that "analysis of the motion perception scores indicates that first graders may also 'see motion' via conventional cues" (Campbell, 1979, p. 152).

Developmental Differences of Implied Motion Interpetation

Amen (1941) used pictures to develop a technique for use as a projective function. The pictures in Amen's study contained scenes that approximated real life experiences in order to elicit emotive responses from her subjects. Amen's subjects were preschool children.

Amen (1941) found developmental differences in children's perceptual reaction to pictures. Among her conclusions, Amen stated that there was "an increase with age of the tendency to interpret picture content in terms of activity, rather than in terms of static form" (365).

Friedman and Stevenson (1975) conducted a study to determine whether pictorial cues that contain structures that are isomorphic to those found in the three-dimensional world are more easy to interpret than those that are less similar to the structures they represent. To test their hypothesis, Friedman and Stevenson chose the variable of movement as it is represented in static pictures because they could systematically control the structural similarity between the pictorial cue and the object, scene, or event it represented in the three-dimensional world. They used pictures which contained representations of still, multiple image, postural cues, and artistic cues (flow lines, blurs, and vibration marks).

Friedman and Stevenson (1975) hypothesized that due to developmental differences, younger subjects would interpret postural cues more readily than cartoon conventions because of the isomorphism of the postural cues with the three-dimensional world. They also hypothesized that older subjects would be able to interpret both the postural cues and artistic conventions used to imply motion. The sample for the study consisted of 23 preschoolers, 25 first graders, 29 sixth graders, and 25 college students. Friedman and Stevenson found differences in the manner in which older and younger subjects interpret postural and artistic cues used for depicting motion. Interpretation of multiple image and the artistic conventions of flow lines, blurs, and vibration marks increased with age. The interpretation of postural cue as movement decreased with age. The interpretation of the still cue as depicting movement also decreased with age. An analysis of age x sex interaction indicated that males of the ages sampled in Friedman and Stevenson's research classify similar percentages of cues as indicating movement. However, with the females there was an increase in classifying movement in pictures as a result of age.

Friedman and Stevenson have suggested that depictions which are more isomorphic are more readily interpreted by the younger members of our culture. Once the artistic conventions indicating movement are learned, they elicit the same response of movement as the postural cues.

Bernard (1978/1979) investigated the ability of children in the preoperational and concrete operational stages of development to recognize implied motion in photographs. His sample consisted of 120 1st- and 2nd-grade subjects. Developmental level of the subjects was determined by scores on the Purdue Conservation Test (PCT). After administering the PCT to the subjects, Bernard chose to analyze the Black subgroup separately because the results of this subgroup's scores on the PCT indicated major differences from those of the White subgroup. He also omitted fourteen subjects that were identified as transitional.

Bernard (1978/1979) presented the four conditions of still object, object blur, object disequilibrium, and background blur. In the still object condition the images did not contain any implied motion cues. The object disequilibrium condition positions the image of the person or object in mid-air. Object blur refers to a technique used to portray motion by blurring the image of the figure against a focused background. Movement is implied in the background blur condition by focusing on the image or object and blurring the field or background.

Bernard (1978/1979) found a significant difference between preoperational and concrete operational subjects' abilities to interpret implied motion in photographs. Children in the concrete operational stage identified movement more often than children in the preoperational stage when presented with the four conditions of implied motion used in Bernard's study. The still object condition was interpreted most frequently. The object blur condition and the background blur condition resulted in similar levels of interpretation. The object disequilibrium condition appeared to present the most difficulties in interpretation.

Saiet (1979) conducted a study to determine if developmental level influenced children's abilities to interpret motion cues. The subjects in this study were 30 4-year-olds, 30 7-year-olds, and 30 11-year-olds. Saiet used flow lines, vibration marks, and blur marks as motion cues and also included an action pose. Saiet used three kinds of objects: human figures, angular geometric figures, and rounded geometric figures. Each of the objects was given an active representation and a static representation. The human figure was portrayed as active by using the action pose. The static representation of the human was conveyed by a vertical standing pose. The angular geometric figures were represented as active by using a rectangle. A square was used to indicate a static representation. An ellipse was used to indicate action for the rounded geometric shapes. A circle indicated a static geometric shape.

Saiet (1979) concluded that all children interpeted the human postural figure as moving whether or not additional motion cues were included with the figure. Subjects in the pre-operational group did not attend to other motion cues and only reported movement in those figures incorporating the postural cue. Older subjects were able to interpret additional motion cues, however, the postural cue was more readily interpreted than other motion cues.

Researchers have found that children vary in their abilities to intepret the dynamic quality that is incorporated in two-dimensional representations through the use of various types of motion cues (Bernard, 1978/1979; Campbell, 1976, 1979; Friedman & Stevenson, 1975; Saiet, 1979). Friedman and Stevenson (1975) attributed the differences in ability to interpret motion cues among subjects of different age levels to the types of motion cues being used. Further, Friedman and Stevenson concluded that "there is a relationship between the ease with which a picture is interpreted and the degree to which the picture retains the structure of the object, scene, or event it represents" (p. 778).

Bernard (1978/1979) and Saiet (1979) used cognitive development as the variable for identifying differences in abilities to interpret various types of implied motion cues. Saiet concluded that children at different stages of cognitive development differ in their abilities to interpret implied motion. Although the results of

Bernard's (1978/1979) study indicated that children in the concrete operational stage of development scored significantly higher than subjects in the preoperational stage of development, Bernard has cautioned interpretations of the result of his study. Because the subjects in Bernard's study were in the 1st and 2nd grades, he has stated that the results of the study were inconclusive to support the interpretation of a theory of development of implied motion interpretation due to possible confounding of age and developmental level.

Summary

Perception enables humans to react to the events and objects that surround them in the environment (Murch, 1973). Humans process most of their information about the environment through the perceptual channel of vision (Murch). Although the physiological process of sight can be explained, many theories exist to explain how the brain interprets the information provided by the eyes. Among the explanations of visual perception, Hagen (1980b) has identified three of the major theories as Constructivist, Gestaltist, and Gibsonian. The Constructivists believe that visual perception occurs as the organism views stimuli and gives meaning to the indistinct information that is gathered from viewing the stimuli. The Gestaltists believe that visual perception occurs as a result of organizational laws that guide the organism to perceive complete units rather than separate stimuli (Murch, 1973).

Gibsonians believe visual perception results from the interaction of light and the structure of the environment.

A special condition of visual perception occurs when two-dimensional representations are used to provide information. Sigel (1978) has stated that any two-dimensional representation can be termed as a picture. Based on Knowlton's classification of pictures, a realistic picture is one in which an aspect of the real world that can be perceived through the visual modality is represented visually. Although humans have perceptual experiences with pictures throughout their lives, Sigel (1978) has stated that relatively little is known about the development of picture perception.

One area of visual perception that has been explored in the research is visual selective attention. Selective attention is the process of accepting and responding to only one message while the perceptual system is receiving several messages (Moray, 1970). Researchers have found that there is a developmental trend in the ability to selectively attend to visual stimuli (Barrett & Shepp, 1988; Day & Stone, 1980; Enns & Cameron, 1987; Lorch & Horn, 1986; Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973; and Smith, Kemler, & Aronfreed, 1975). Researchers of selective attention have also discovered that there is a developmental trend in children's abilities to filter out other stimuli when trying to visually attend to specific stimuli (Barrett & Shepp, 1988; Day & Stone, 1980; Enns & Cameron, 1987; Lorch & Horn, 1986; Pick, Christy, & Frankel, 1972; Pick & Frankel, 1973; and Smith, Kemler, & Aronfreed, 1975).

Researchers in selective attention have studied the effects of various attention directing strategies on children's abilities to attend to relevant visual information. Dusek (1978) concluded that labeling facilitates central learning. Miller (1978) and Day (1978) concluded that color is a more effective cueing strategy than form. Rosonke (1974/1975) found that pointers were effective cueing strategies for 1st-grade children.

In the area of picture interpretation, one aspect of importance is the ability to perceive the dynamic quality of implied motion from still pictures (Travers & Alvarado, 1970). Researchers in this area have indicated that the ability to interpret motion cues is a developmental trend (Bernard, 1978/1979; Friedman & Stevenson, 1975; and Saiet, 1979). In addition, researchers have reported that young children are more able to interpret motion when the cues are more isomorphic with the real world. Young children were more successful at interpreting postural cues than other more symbolic motion cues such as flow lines, vibration marks, blur marks, object disequilibrium, or multiple images (Bernard, 1978/1979; Campbell, 1976; Friedman & Stevenson, 1975; and Saiet, 1979).

Research in the field of visual perception has been conducted by theorists from many diverse fields without regard to relevant research from other areas (Levie, 1987). As a result, some consistent research findings about the developmental trends of visual selective attention have not been incorporated into the research on interpretation of implied motion in two-dimensional representations.

CHAPTER 3
METHODOLOGY

This study was designed to determine if there are differences between children of two age groups in their abilities to attend to the dynamic property of motion in two-dimensional representations due to the effect of types of motion cue. In addition, information was added to the two-dimensional representations to determine if the addition of information would affect children's abilities to attend to the motion cues. A visual highlight was incorporated in the presentation of two-dimensional representations to determine if cueing children's visual attention would affect their abilities to interpret implied motion cues.

Research Design

A 2x3x3x3 split-plot factorial design with repeated measures was used for the study (Keppel, 1982; Kerlinger, 1986). Factor A (grade) had two levels: (1) kindergarten, and (2) 3rd-grade children. Factor B (group) consisted of three groups: group 1 (picture series 1), group 2 (picture series 2), and group 3 (picture series 3). Factor C (types) consisted of three types of motion conditions: (1) no motion as indicated by a still figure; (2) motion as indicated by a postural figure; and (3) motion as indicated by the symbols of flow lines extending from the figure. Factor D (level of information) had three levels: (1) no additional information; (2)

additional background information; (3) additional background information with the addition of a highlighting cue (Table 1).

Table 1
2 x 3 x 3 x 3 Split-Plot Design with Repeated Measures

		Kindergarten			Third Grade		
		Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
Group 1	Level 1						
	Level 2						
	Level 3						
Group 2	Level 1						
	Level 2						
	Level 3						
Group 3	Level 1						
	Level 2						
	Level 3						

Kerlinger (1986) has identified three advantages of the factorial design. First, a factorial design allows for the manipulation and control of more than one variable. A factorial design is more precise than a one-way analysis. A third advantage to using factorial designs "is the study of interactive effects of independent variables on dependent variables" (p. 245).

Population

The population for this study consisted of kindergarten and 3rd-grade children enrolled in a public elementary school in Marion County, Florida. The breakdown of the student population by race and sex in the elementary school was as follows: White-79.2%, Black-18.4%, Hispanic-1.9%, Asian-.05%; Male-49.6%, Female-50.4%.

Sample

The sample for this study was drawn from an elementary school in Marion County, Florida. The subjects were kindergarten and 3rd-grade students. Three kindergarten classrooms and three 3rd-grade classrooms were chosen by the assistant principal to serve as potential subjects.

Prior to any contact with the students in the six classrooms, each kindergarten and 3rd-grade child's parent in the selected classrooms was sent a parental consent form that described the procedures that would be used in the data collection. A total of 16 kindergarten males, 21 kindergarten females, 17 third-grade males, and 29 third-grade females responded by returning signed parental consent forms. From this group of initial responses, one 3rd-grade girl was not included in the pool of potential subjects because she had been identified as having a learning disability. The

16 kindergarten males were randomly assigned to the three experimental groups; 20 kindergarten females were randomly selected and randomly assigned to the three experimental groups. There were 17 third-grade males randomly assigned to the three experimental groups and 19 female third-grade students randomly selected and randomly assigned to the three experimental groups. A total of 36 kindergarten subjects and 36 third-grade subjects participated in the study.

Stimuli

A series of 72 black-line drawings were used to determine each child's ability to attend to motion or lack of motion using various cues conventionally utilized to imply motion in two-dimensional representations. Based on Knowlton's (1966) classification of pictures, the stimuli used in this study were realistic pictures because they were created for the purpose of making reference to the type of object that was portrayed in the visual.

The 72 two-dimensional black-line drawings were produced by a graphic artist. The subjects in these representations were twelve different animals typical of the subjects found in children's books. The animals were an elephant, lion, horse, mouse, dog, cat, cow, zebra, rabbit, fox, squirrel, and giraffe. The drawings of the animals were designed so each animal was centered within each illustration. The drawings were also designed to provide variance in the direction of the animals' movements, some of the animals were drawn facing to the right in the visual and some of them were facing to the left.

Each of the animal figures was drawn in three different motion conditions: (1) still, indicating no motion; (2) postural, indicating motion; and (3) flow lines, indicating motion. The artist researched each of the animals to determine their correct physical posture for standing still and walking. This information was incorporated into the design of the visuals. Flow lines were placed around various parts of the different animals (tails, ears, head, and trunk) to prevent subjects from associating the flow lines with any particular part of the animals.

The 36 illustrations depicting the twelve animals in three different conditions of motion consisted of the animal figure, the motion cue, and a horizon line. This set of 36 pictures was used as level 1 of Factor D (level of information). The graphic artist then duplicated these 36 original drawings so that the figures remained the same size, in the same position, and with the same motion cues. The artist then added details of appropriate background information (trees, plants, clouds, etc.) to create 36 additional drawings. This second set of 36 drawings with the added background information served as the stimuli for level 2 of Factor D. All of the illustrations produced by the graphic artist were converted to 35mm slides for this experiment.

The 36 drawings that contained the additional background information were utilized in level 3 of Factor D with the addition of a highlighting cue. The purpose of this highlighting technique was "to ensure that the intended instructional stimuli are emphasized in such a way that they will be quickly perceived from among all stimuli in the student's total perceptual field" (Dwyer, 1978, p. 160). The highlighting cue was a circle of light that was projected on the screen in the area that contained the motion cue. The highlighting technique was achieved by creating a visual mask for each of the 36 drawings used for this condition. The mask was solid black except for a circle constructed so that it matched the area of the drawing that contained the motion cue. To achieve the highlighting technique for the level 3 condition of information, each of the 36 illustrations used in this condition was projected onto the screen; immediately following the projection of the visual, the highlighting cue was projected so that both images appeared on the screen simultaneously. The highlighting technique did not block out any of the remainder of the visual, but simply added a circle of light to the part of the visual containing the motion cue.

A total of nine different pictorial conditions were created for each of the animals chosen for the illustrations in this study. Each animal was represented in three motion conditions of no motion, postural position, and flow lines. Each of these three motion conditions was replicated under the conditions of no background information, additional background information, and additional background information with a highlighting cue (Appendix).

Thus the stimuli for this experiment were designed for two purposes. First, it was necessary that the visuals designed for this study contain different types of motion cues to determine if children were capable of identifying motion when it was portrayed using isomorphic representation (postural cue) as well as symbolic representation (flow lines). Second, the stimuli needed to contain different levels of information to determine if the level of information contained within the visual would have an effect on children's interpretations of the implied motion cues. Finally, a cueing strategy needed to be developed to determine if focusing a subject's attention on relevant information would affect the subject's ability to interpret implied motion cues.

Procedure

The pictures were divided into sets and rotated across subject groups to eliminate the possible confounding due to repeated exposures within the treatment conditions. The illustrations were divided into three groups. The group division was made so that there would be a similar distribution of large and small animals contained in the drawings for each group. Each of these three groups of animal illustrations was represented in three different motion conditions and repeated in three different levels of information for a total of 27 sets of pictures. Each of the three groups of subjects viewed nine sets of pictures with four pictures in each set for a total of 36 responses per child. Within each set of nine picture groups, none of the animal pictures was repeated

Table 2
Picture Series

		Kindergarten			Third Grade		
		Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
Group 1	Level 1	P1	P2	P3	P1	P2	P3
	Level 2	P3	P1	P2	P3	P1	P2
	Level 3	P2	P3	P1	P2	P3	P1
Group 2	Level 1	P3	P1	P2	P3	P1	P2
	Level 2	P2	P3	P1	P2	P3	P1
	Level 3	P1	P2	P3	P1	P2	P3
Group 3	Level 1	P2	P3	P1	P2	P3	P1
	Level 2	P1	P2	P3	P1	P2	P3
	Level 3	P3	P1	P2	P3	P1	P2

P1 = elephant
cow
mouse
fox

P2 = cat
rabbit
giraffe
zebra

P3 = lion
horse
squirrel
dog

across condition type or level of information for any of the groups (Table 2). There were three groups of kindergarten subjects and three groups of 3rd-grade subjects. Each subject received all levels of factor A (condition of motion) and all levels of factor B (level of information).

Each child was tested individually. In order to prevent the subjects from becoming tired during the experiment, each subject viewed 12 slides during three separate sessions. No child participated in more than one session on any day. During each of the three sessions, pictures for each group of subjects contained combinations of all of the condition types and levels of information so that each group received exposure to the varying factors during each of the sessions. The sequence of the pictures within each group remained constant throughout the experiment. The experiment was conducted in a conference room that was adjacent to the guidance counselor's office and housed within the guidance suite. The room contained a conference table, chairs, and filing cabinets. A Chief Model MSU-20 stand was used to secure two Kodak Ektagraphic III E slide projectors. A Clear Light Micro Diamond Dissolve control panel was attached to the two slide projectors so that the highlighting technique could be achieved. An audio cassette tape recorder was placed on the conference table and each session was audio recorded. The subjects sat at the conference table next to the experimenter. The slides were projected onto a small screen located approximately 3' - 4' from the subject.

The experimenter went to each child's classroom and escorted the child from the classroom to the conference room for each session. The same experimenter collected the data for all groups and all sessions. Prior to each child's initial session, the experimenter explained the presence of the equipment to each child. The experimenter then explained the procedures to each child by stating the following: "Today we are going to look at some pictures. All of the pictures that we will be seeing today are pictures of animals. When one of the pictures comes up on the screen I want you to look at it. Then I am going to ask you a question about the picture that you are looking at." The subject was then asked if they had any questions about the procedures. Once it was determined that the child was comfortable in the experimental setting, the experimenter proceeded with the session. The experimenter projected a slide of one of the visuals and asked the child the following question: "What can you tell me about the (name of the animal) in this picture?" The experimenter wrote down the child's response, projected the next visual, and repeated the question: "What can you tell me about the (name of the animal) in this picture?" This procedure continued for 12 pictures during each of the three sessions for each child. Because one of the purposes of the present study was to determine what children selectively attend to in a visual, the children were allowed to respond to the pictures by stating any information that they wanted to present. The experimenter did not provide the subjects with verbal feedback on their responses during the experimental sessions. At the end of each session, each subject received a sticker as a reward and the experimenter escorted the child back to the classroom.

The data were collected during a 4-week period. After the data were collected, each child's responses were evaluated and judged as correct or incorrect. The responses were judged on the following criteria:

1. The still motion condition was judged correct when the child did not indicate any movement of the animal was occurring in the visual.
2. The postural and flow line conditions were judged correct if the child's response indicated that the scene in the picture represented that some motion involving the animal was occurring in the picture.

Examples of correct still motion responses were "he's standing still," "the zebra has stripes," and "the squirrel is short." Examples of still motion responses that were judged as incorrect were "the cow is walking," "the mouse is walking around," and "the squirrel is hopping toward something."

Examples of responses to the postural motion cue that were judged as correct were "it's running and smiling," "it's walking slowly," and "it hops fast." Examples of responses to the postural cue that were considered incorrect were ""it has a long trunk," "the rabbit is a pet," and "the zebra is nice." Examples of flow line condition responses that were judged as correct were "the tail is wiggling," "the horse is looking down," and "the elephant is wiggling its trunk back and forth." Examples of flow line condition responses that were judged incorrect were "the fox is sad," "the lion is big, " and "the rabbit has long ears."

Summary

The present study was designed to determine the differences between kindergarten and 3rd-grade subjects in their abilities to attend to motion cues used in two-dimensional representations. The levels of information in the two-dimensional representations were varied to determine if added information affects a child's ability to attend to the implied motion cues. A highlighting technique was incorporated to determine if a cueing strategy would be an effective method of directing attention to the motion cues. A 2x3x3x3 split-plot factorial design with repeated measures was used for the study.

The subjects in the study were 36 kindergarten students and 36 third-grade students. Each subject viewed a total of 36 visuals during three separate experimental sessions. The visuals were designed to represent three different conditions of motion. In addition, the visuals contained either no visual background information, additional visual background information, or additional visual background information with a cueing strategy.

CHAPTER 4
ANALYSIS OF THE DATA

The purpose of this study was to determine the difference between kindergarten children and 3rd-grade children in their abilities to attend to motion cues in two-dimensional representations when the motion conditions and the levels of information within the two-dimensional representations are varied. A cueing strategy was utilized to determine in focusing of attention would effect children's abilities to interpret motion cues. The design of the study was a 2x3x3x3 split-plot factorial design with repeated measures.

Results

The data were analyzed with a repeated measures analysis of variance. Each of the hypotheses are stated in the operational null form. The relevant statistics are presented in ANOVA summary tables. In addition, descriptive statistics are included for significant interactions.

> Hypothesis 1: There is no significant difference between kindergarten children and 3rd-grade children in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied.

The repeated measures of analysis of variance was performed with an obtained F of 15.46 (p<.05, df=1) for the main effect between subjects treatment of grade level (Table 3). The F ratio of 15.46 was significant; therefore, the null hypothesis was rejected. The means and standard deviations for grade level are presented in Table 4.

Table 3
Source Table of Analysis of Variance of Grade and Group

Source	SS (Type III)	DF	MS	F
Between Subjects				
Grade	59.89	1	59.89	15.46*
Group	9.91	2	4.95	1.28
Grade X Group	0.20	2	0.10	0.03
Error	255.73	66	3.87	

* Significant at p<.05

Table 4
Means and Standard Deviations for Grade

Grade	M	SD
Kindergarten	2.17	1.07
3rd Grade	2.78	1.02

> Hypothesis 2: There is no significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied.

The analysis resulted in an F of 1.28 at df = 2 (Table 3). Because an F ratio of 1.28 is not significant at .05 level, this null hypothesis was not rejected.

> Hypothesis 3: There is no significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied due to an interaction effect of grade level and experimental group.

The interaction effect of grade by group had an F of 0.03 at df = 2 (Table 3). An F ratio of 0.03 is not significant at the .05 level. Therefore, this null hypothesis could not be rejected.

> Hypothesis 4: There is no significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to the level of information in the visual.

The analysis of variance was computed and yielded an F ratio of 4.12 at df = 2 (Table 5). The F ratio was significant at the $p<.05$ level. The null hypothesis was rejected.

> Hypothesis 5: There is no significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and grade level.

The computed F ratio for the interaction of level and grade was F = 0.49, df = 2 (Table 5). Because the F ratio was not significant at the .05 level, this hypothesis was not rejected.

Table 5
Source Table of Analysis of Variance of Level by Grade and Group

Source	SS (Type III)	DF	MS	F
Within Subjects				
Level	4.09	2	2.05	4.12*(**)
Level X Grade	0.48	2	0.24	0.49
Level X Group	11.60	4	2.90	5.82*(**)
Error (Level)	67.81	136	.49	

* Significant at $p<.05$
(**) Significant with Geisser-Greenhouse adjustment at $p<.05$

> Hypothesis 6: There is no significant difference in children in their abilities to visually attend to three

types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and experimental group.

The obtained F ratio for the level and group interaction was F = 5.82 and df = 4 (Table 5). The F ratio was significant at the .05 level. Therefore, this null hypothesis was rejected.

The group means and standard deviations for level and group are presented in Table 6. Group 1 appeared to have the lowest score at level 2 while the difference between the mean scores for level 2 and level 3 for group 1 was .05. Group 2 achieved a higher overall mean at level 3. Group 3 performance was better at level 2. A plot of the level and group means is provided in Figure 1.

Table 6
Means and Standard Deviations for Level and Group

	Level					
Group	Level 1		Level 2		Level 3	
	M	SD	M	SD	M	SD
Group 1	2.74	1.04	2.23	.87	2.69	1.15
Group 2	2.50	.97	2.48	1.13	2.75	1.10
Group 3	2.22	1.07	2.41	1.03	2.28	1.05

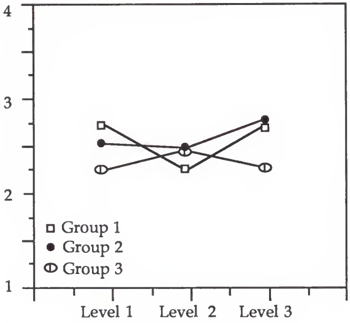


Figure 1. Means of Levels and Groups.

Hypothesis 7: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to the type of motion condition used.

The F ratio for type of motion condition was 108.13 at df = 2 (Table 7). Because an F of 108.13 is significant at the p<.05 level, this null hypothesis was rejected.

Hypothesis 8: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition and grade level.

The computed F for type by grade was 4.24 at df = 2 (Table 7). An F ratio of 4.24 is significant at p<.05. Therefore, this null hypothesis was rejected.

Table 7
Source Table of Analysis of Variance of Type by Grade and Group

Source	SS (Type III)	DF	MS	F
Within Subjects				
Type	479.72	2	239.86	108.13*(**)
Type X Grade	18.83	2	9.41	4.24*(**)
Type X Group	7.85	4	1.96	.88
Error (Type)	301.61	136	2.22	

* Significant at p<.05
(**) Significant with Geisser-Greenhouse adjustment at p<.05

The mean results for type by grade level are provided in Table 8. The results for type and grade level are plotted in Figure 2. It appears that for both kindergarten and 3rd grade, there was a decrease in performance between the type 1 and type 2 motion condition. There was also a decrease for both grade levels between the type 2 and type 3 motion condition.

Hypothesis 9: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition used in the visual and group.

Table 8

Means and Standard Deviations for Type and Grade Level

Grade	Type 1		Type 2		Type 3	
	M	SD	M	SD	M	SD
Kindergarten	3.59	.65	1.73	1.38	1.20	1.27
3rd Grade	3.77	.50	2.37	1.33	2.21	1.36

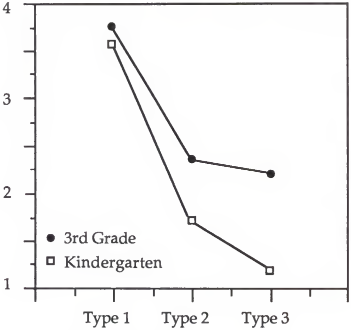


Figure 2. Means of Type and Grade Level.

The computed F ratio for type by group was 1.96 at df = 4 (Table 7). An F ratio of 1.96 is not significant at p<.05 level. Therefore this null hypothesis was not rejected.

> Hypothesis 10: There is no significant difference in children in their abilities to interpret motion in two-dimensional representations due to the interaction of level of information contained in the visual and type of motion condition contained in the visual.

The F ratio for level by type was 4.14 at df = 4 (Table 9). Because an F of 4.14 is significant at p<.05 level, this null hypothesis was rejected.

There was a decrease in subject performance between those pictures containing type 1 and type 2 conditions of motion at all three levels of information (Table 10). Scores on the type 2 motion condition appear to be higher at level 3 information. The type 2 motion condition is lowest with the level 2 information. In addition, performance on type 3 condition of motion declined at all levels. Performance on the type 2 condition of motion was highest at the level 3 information. Performance on the type 3 condition of motion was highest at level 1 information.

The mean scores for the type 1 condition of motion showed a slight decrease for the level 3 information (Figure 3). Type 2 condition of motion had the highest mean score at level 3 and the lowest score for type 2 was at level 2. Type 3 was highest at level 1 information and lowest at level 2 information.

Table 9
Source Table of Analysis of Variance of Level by Type

Source	SS (Type III)	DF	MS	F
Within Subjects				
Level X Type	10.25	4	2.56	4.14*(**)
Error (Level X Type)	175.75	284	.62	

* Significant at p<.05
(**)Significant with Geisser-Greenhouse adjustment at p<.05

Table 10
Means and Standard Deviations for Level and Type

	Level					
Type	Level 1		Level 2		Level 3	
	M	SD	M	SD	M	SD
Type 1	3.69	.60	3.69	.52	3.65	.60
Type 2	1.96	1.22	1.80	.98	2.39	1.44
Type 3	1.80	1.26	1.64	1.37	1.68	1.26

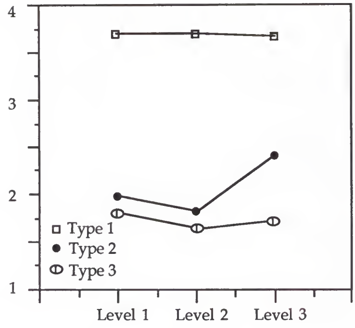


Figure 3. Means of Level and Type.

Summary

There was a significant interaction between level of information contained in a visual and experimental group. The variable of grade was significant on subjects' abilities to interpret three types of motion conditions. The ability to interpret types of motion cues was also influenced by the level of information contained within each of the two-dimensional representations.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this study was to determine if there are differences between kindergarten and 3rd-grade children in their abilities to attend to motion cues in two-dimensional representations when the motion conditions and levels of information are varied. A highlighting cue was utilized in one condition to determine the effect of a cueing strategy to direct attention to specific motion information contained in the visuals.

A 2x3x3x3 split-plot factorial design with repeated measures was used to investigate the treatment effects. There were 36 kindergarten subjects and 36 third-grade subjects that participated in the study. The participants were randomly assigned to three different experimental groups. All of the experimental groups viewed pictures of animals. The pictures had been reproduced as slides. Each of the visuals contained three types of motion conditions: (a) still, no motion indicated; (b) postural, the animal was positioned to indicate walking or running movement; (c) flow lines, lines were added around various parts of the animal to indicate motion. Each of these three motion conditions were repeated with three different levels of information contained in the visuals. The three levels of information were (a) no additional information, the animal was drawn with only a horizon line to provide placement; (b) added background information, the animal with the horizon line was duplicated and background information such as trees, bushes, and clouds were added; (c) highlighting cue, the level 2 visual, containing the additional background was duplicated and a masking technique was used to produce a circle of light around the motion cue as the visual was projected. Each child saw three sets of twelve slides for a total of 36 responses per subject.

Findings

The data were analyzed with a repeated measures analysis of variance. Each of the hypotheses is stated in the operational null form.

> Hypothesis 1: There is no significant difference between kindergarten children and 3rd-grade children in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied.

The null hypothesis was rejected.

> Hypothesis 2: There is no significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied.

The null hypothesis was not rejected.

Hypothesis 3: There is no significant difference among experimental groups in their abilities to visually attend to three types of motion conditions when these conditions occur in two-dimensional representations in which the level of information has been varied due to an interaction effect of grade level and experimental group.

The null hypothesis was not rejected.

Hypothesis 4: There is no significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to the level of information in the visual.

The null hypothesis was rejected.

Hypothesis 5: There is no significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and grade level.

The null hypothesis was not rejected.

Hypothesis 6: There is no significant difference in children in their abilities to visually attend to three types of motion conditions in two-dimensional representations due to an interaction effect of the level of information in the visual and experimental group.

The null hypothesis was rejected.

Hypothesis 7: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to the type of motion condition used.

The null hypothesis was rejected.

Hypothesis 8: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition and grade level.

The null hypothesis was rejected.

Hypothesis 9: There is no significant difference in children in their abilities to visually attend to motion in two-dimensional representations due to an interaction effect of type of motion condition used in the visual and group.

The null hypothesis was not rejected.

Hypothesis 10: There is no significant difference in children in their abilities to interpret motion in two-dimensional representations due to the interaction of level of information contained in the visual and type of motion condition contained in the visual.

The null hypothesis was rejected.

Discussion

Grade Level

There was a significant difference between kindergarten and 3rd-grade children's abilities to attend to motion conditions in the two-dimensional representations used in this study. The 3rd-grade subjects had mean scores of 3.77 for the type 1 motion condition, 2.37 for the type 2 motion condition, and 2.21 for the type 3 motion condition. This indicates that 3rd-grade students can interpret the dynamic quality of motion when it is implied in two-dimensional representations. It also indicates that 3rd-grade subjects do not experience much difference when interpreting motion depicted by a postural cue or by flow lines.

The mean scores for the kindergarten subjects were 3.59 for type 1 motion condition, 1.73 for type 2 motion condition and 1.20 for type 3 motion condition. The results of this study indicate that although kindergarten subjects can interpret the dynamic quality of motion in two-dimensional representations, they are not as skilled at seeing motion as are 3rd-grade subjects. Further, the results of this study indicate that kindergarten subjects experienced more difficulty when trying to interpret flow lines used to depict motion in the type 3 condition of motion than when they were interpreting the postural cues used in the type 2 condition of motion.

Level of Information

Added information The results of this study indicate that the level of information contained in a visual has an effect on children's abilities to attend to motion cues in two-dimensional representations. Additional background information presented in the level 2 pictures resulted in the lowest scores for the type 2 (postural) pictures and the type 3 (flow line) visuals. The additional information presented in the level 2 pictures resulted in the lowest mean scores for level of information for both kindergarten and 3rd-grade subjects.

The results of the data on the variable of added information in the present study suggest that young children have a problem attending to specific aspects of a picture when visual information is added. These findings support Travers and Alvarado's (1970) statement that "the young child's problem in dealing with pictorial material, even when it involves common scenes, stems from his limited capacity to handle simlutaneously information from the different sources in the picture" (p. 56).

Highlighting cue The level 3 pictures contained a highlighting cue for directing students attention to the parts of the visual that contained the motion information. The highlighting cue utilized in level 3 was an effective technique for directing subjects' attention to the motion cues used in the type 2 and type 3 pictures. The highlighting cue was slightly less effective for the type 1 picture in which no motion was indicated. Both kindergarten and 3rd-grade subjects achieved the highest mean scores with the highlighting cue used in level 3.

The use of a highlighting cue was an effective strategy for focusing attention in the present study. Subjects in kindergarten and 3rd grade were more successful at interpreting postural and flow line motion cues when the cueing strategy was present. These findings support the statement by Travers and Alvarado (1970) that "a minimum condition for receiving information from a picture is that the person involved attend to it" (p. 56). Further, the results of the cueing strategy variable indicate that children's attention can be directed to specific information in a visual. This result occurred even when the subject did not have any meaning to attach to highlighted information. On several responses, the subjects noted "the lines above the head" or "the lines under the tail" in reference to the flow lines but the subjects did not comprehend the meaning of the lines.

Type of Motion Condition

The results of this study indicate that the type of cue used to imply motion in two-dimensional representations has an effect on children's abilities to attend to the dynamic quality of implied motion in pictures. The overall mean for type 1 pictures in which no motion was implied was 3.68. The overall mean for the type 2 pictures which contained animals in postural positions to indicate motion was 2.05. The overall mean for the type 3 pictures which utilized flow lines to indicate motion was 1.69. The mean for the type 1 pictures indicates that children do not arbitrarily imply motion to animals illustrated in two-dimensional representations.

The difference between the means of the type 2 and type 3 pictures indicates that children more readily interpret motion that is more isomorphic with the real world. The postural condition of implying motion incorporates a frozen frame of what the viewer would see from a single viewpoint at a single moment if motion were occurring (Friedman & Stevenson, 1980). The flow lines are symbolic representations that are used to indicate movement of wind or air around that part of the object that is portrayed as moving. Friedman and Stevenson (1980) have referred to this technique as pictorial metaphor.

The results of the present study support the findings of previous research on the perception of movement in pictures. Friedman and Stevenson (1975) found that young children were capable of interpreting motion when the postural condition is used to imply movement. Friedman and Stevenson (1975) also found that younger children experienced greater difficulty when interpreting motion that had been represented through the use of flow lines. Travers and Alvarado have stated that flow lines represent "a set of signs" (1970, p. 51). Students in kindergarten and 3rd grade are not as successful at utilizing the information conveyed by these symbols as the information conveyed in a frozen frame approach that is more representative of a real world view.

Implications

The results of this study indicate that there are differences among children in their abilities to attend to implied motion in pictures. Pictures that contain implied motion are utilized at all levels of education for instructional purposes. Teachers should be aware that some students may be limited in the amount of information they are able to gain from two-dimensional representations. As Hurt has stated, "Different learners experience different levels of success in gaining information from pictures in various instructional tasks" (1989, p. 24) Therefore, teachers should include an introduction to a visual when utilizing it in an instructional situation. When introducing an instructional visual to students, teachers should provide some cues that direct student's attention to the specific information that the student is intended to garner from the visual. In the present study a highlighting technique was utilized to direct attention. However, teachers could employ different attention directing strategies including verbal cues. Once attention has been directed to a critical aspect of a picture, teachers should employ various techniques to determine that children are correctly interpreting the visualized information. For example, when appropriate, students might be encouraged to discuss the information in a picture and to question those aspects of the picture that they do not understand. Teachers should ascertain that students have an understanding of the concepts or information contained in the visuals prior to using the visuals in an instructional context.

Instructional designers should be aware that not all children attend to the dynamic quality of implied motion in two-dimensional representations. Caution should be exercised when incorporating implied motion cues into materials for instructional or evaluation purposes. Children in kindergarten and 3rd grade do not consistently attend to motion cues. Children at both grade levels interpret postural motion cues at higher levels of accuracy than flow lines used for indicating motion. Therefore, when designing visuals that are intended to portray motion, instructional designers should incorporate postural cues rather than flow lines if the target audience is primary age children.

The addition of information in a visual can cause a decrease in the ability of kindergarten and 3rd-grade children to attend to motion cues. Children at these age levels perform with a higher degree of consistency when no background information is added. Because of these findings, care should be exercised when adding peripheral information to visuals that will be used by primary age children. If background information is not an integral instructional aspect of the visual, designers should consider eliminating any additional information that might interfere with the viewer's ability to attend to the critical aspects of the picture.

The results of this study indicate that a cueing strategy is an effective means of directing attention to motion cues utilized in two-dimensional representations for kindergarten and 3rd-grade children. When materials containing visuals are designed and produced, experts in the field of message design should incorporate some type of cueing strategy into the design of the materials.

Recommendations

The following recommendations are made for future studies in this area:

1. Different highlighting techniques could be included to determine if different cueing strategies increase children's abilities to attend to certain aspects of dynamic visuals.
2. Different subjects could be used in the visuals to determine if children more readily interpret motion when different categories such as humans or inanimate objects are portrayed with motion cues.
3. Color could be added to the visuals to determine if children interpret motion from implied motion cues to a greater degree due to a more realistic representation of the real-world scenes.
4. Other objects could be included in the visual to indicate that the animal is moving toward a goal (for example, food for the mouse, a barn for the cow).
5. Studies could be designed to include additional questioning strategies to determine if children are attending to motion but are not expressing it.

6. Color could be used as a cueing device to determine if the contrast between a color cueing device and a black and white visual is an effective strategy for focusing attention.
7. Additional irrelevant information could be added to visuals to determine the level of additional information that affects attention.
8. Studies could be designed to determine if visual experience is a factor in determining successful interpretation of motion cues.
9. Studies could be designed to determine if visual experience is a factor in attending to relevant information in two-dimensional representations.
10. Older subjects could be included to compare abilities of subjects in various age groups.
11. Replications of this study could be performed to attend to the null hypotheses that were not rejected as a result of the present study.

Summary

Researchers in educational media have been confronted with a plethora of gross media comparison studies. The results of these studies have not provided practitioners with sufficient information to effect the design of educational media. Theorists have suggested that it is necessary to explore the specific attributes contained within the various symbol systems that are utilized in different media formats. Visualized messages are incorporated in many media formats and are widely used at all levels of education.

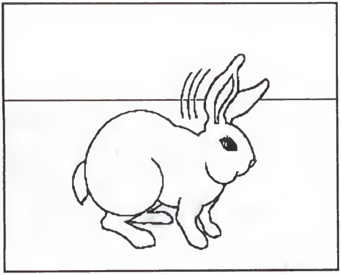
Pictures present a special case of visual perception. Pictures are two-dimensional representations that are designed by someone for the purpose of communicating a message. Often, these two-dimensional representations are designed to portray a three-dimensional quality. It is known that children do not possess the same spatial skills as adults. Although pictures are used at all levels of education, little is known about the acquisition of pictorial information by children.

Although little is known about how children come to understand the information in pictures, there is evidence that there are differences in visual abilities of children at different age levels. For example, there are developmental trends in children's abilities to selectively attend to visual information. In addition, there is a developmental trend in chldren's abilities to filter out other stimuli when trying to visually attend to specific visual stimuli.

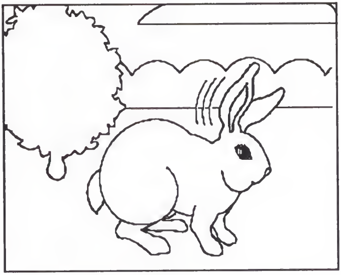
This study was designed to incorporate the results of studies in visual selective attention with children's abilities to interpret the dynamic quality of motion in pictures. Specifically, the purpose of this study was to determine if there are differences between kindergarten children and 3rd-grade children in their abilities to attend to motion cues in two-dimensional representations when the motion conditions and levels of information are varied.

The results of this study indicate that there are differences among children of two age groups in their abilities to attend to implied motion cues in two-dimensional representations. The children in the present study were more successful when interpreting postural cues than flow lines. The addition of information in a visual decreased the ability of children to attend to motion cues. In addition, the use of a visual cueing strategy was an effective method for directing children's attention to motion cues.

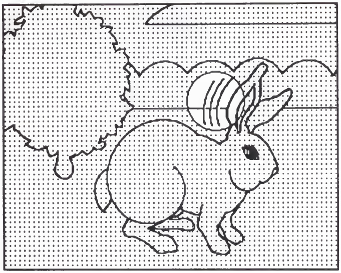
APPENDIX
SAMPLE VISUAL SET



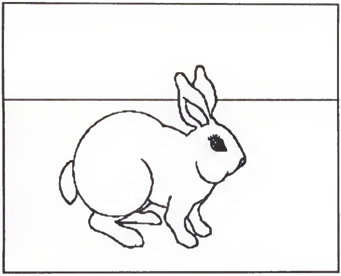
Type 3 motion condition - flow lines
Level 1 - no background information



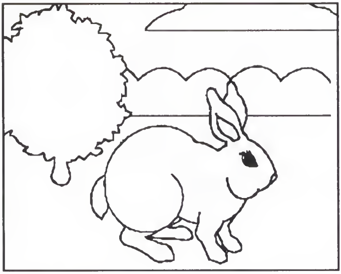
Type 3 motion condition - flow lines
Level 2 - additional back ground information



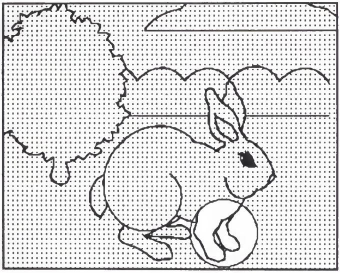
Type 3 motion condition - flow lines
Level 3 (Simulated) - highlighting technique



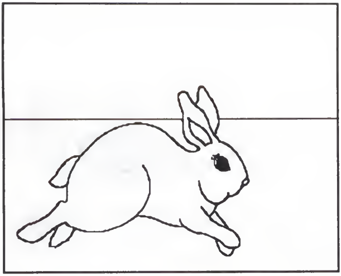
Type 1 motion condition - still
Level 1 - no background information



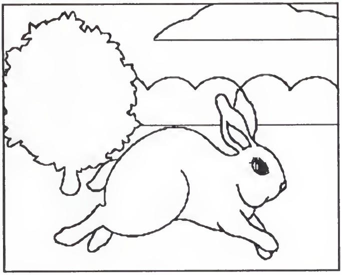
Type 1 motion condition - still
Level 2 - additional background information



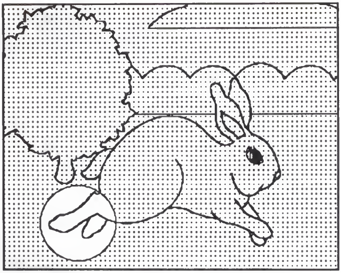
Type 1 motion condition - still
Level 3 (Simulated) - highlighting technique



Type 2 motion condition - postural
Level 1 - no background information



Type 2 motion condition - postural
Level 2 - additional background information



Type 2 motion condition - postural
Level 3 (Simulated) - highlighting technique

REFERENCES

Allen, W. H. (1971). Instructional media research: Past, present, and future. AV Communication Review, 19(1), 5-18.

Amen, E. W. (1941). Individual differences in apperceptive reaction: A study of the response of preschool children to pictures. Genetic Psychology Monographs, 23, 319-385.

Barrett, S. E., & Shepp, B. (1988). Developmental changes in attentional skills: The effect of irrelevant variations on encoding and response selection. Journal of Experimental Child Psychology, 45, 382-399.

Bartley, H. S. (1980). Introduction to perception. New York: Harper & Row.

Bernard, R. M. (1979). Recognition of implied motion in four static image conditions by preoperational and concrete operational first and second graders. (Doctoral dissertation, University of Washington, 1978). Dissertation Abstracts International, 40, 619A.

Broadbent, D. E. (1958). Perception and communication. New York: Pergamon Press.

Campbell, P. F. (1976). The role of pictures in first grade children's perception of mathematical relationships (PMDC Technical Report No. 8). Tallahassee: Florida State University, Project for the Mathematical Development of Children. (ERIC Document Reproduction Service No. ED 144 807)

Campbell, P. F. (1979). Artistic motion cues, number of pictures, and first-grade children's interpretation of mathematics textbook pictures. Journal for Research in Mathematics Education, 10, 148-153.

Chapman, M. (1981). Dimensional separability or flexibility of attention? Age trends in perceiving configural stimuli. Journal of Experimental Child Psychology, 31, 332-349.

Clark, R. E. (1983). Reconsidering the research on learning from media. Review of Educational Research, 53, 445-459.

Clark, R. E. (1987, February). Which technology for what purpose?: The state of the argument about research on learning from media. In M. R. Simonson (Chair), ...Mere Vehicles.... Symposium conducted at the Annual Convention of the Association for Educational Communications and Technology, Atlanta, GA.

Day, M. C. (1978). Visual search by children: The effect of background variation and the use of visual cues. Journal of Experimental Child Psychology, 25, 1-16.

Day, M. C., & Stone, C. (1980). Children's use of perceptual set. Journal of Experimental Child Psychology, 29, 428-445.

Dember, W. N., & Warm, J. S. (1979). Psychology of perception (2nd ed.). New York: Holt, Rinehart and Winston.

Deregowski, J. B. (1980). Illusions, patterns and pictures: A cross-cultural perspective. London: Academic Press.

Downs, E. (1988). Young children's interpretations of implied motion cues. Unpublished manuscript.

Dusek, J. B. (1978). The effects of labeling and pointing on children's selective attention. Developmental Psychology, 14(1), 115-116.

Dwyer, F. M. (1978). Strategies for improving visual learning. State College, Pennsylvania: Learning Services.

Enns, J. T., & Cameron, S. (1987). Selective attention in young children: The relations between visual search, filtering, and priming. Journal of Experimental Child Psychology, 44, 38-63.

Enns, J.T., & Girgus, J. (1985). Developmental changes in selective and integrative visual attention. Journal of Experimental Child Psychology, 40, 319-337.

Fleming, M., & Levie, W. (1978). Instructional message design: Principles from the behavioral sciences. Englewood Cliffs, NJ: Educational Technology Publications.

Friedman, S. L., & Stevenson, M. (1975). Developmental changes in the understanding of implied motion in two-dimensional pictures. Child Development, 46, 773-778.

Friedman, S. L., & Stevenson, M. (1980). Perception of movement in pictures. In M. A. Hagen (Ed.), The perception of pictures: Vol. I. Alberti's window: The projective model of pictorial information (pp. 225-255). New York: Academic Press.

Gibson, E. J. (1969). Principles of perceptual learning and development. New York: Appleton-Century-Crofts.

Gibson, J. J. (1971). The information available in pictures. Viewpoints, 47(4), 73-95.

Gibson, J. J. (1980). Foreword: A prefatory essay on the perception of surfaces versus the perception of markings on a surface. In M. A. Hagen (Ed.), The perception of pictures: Vol. I. Alberti's window: The projective model of pictorial information. (pp. xi-xvii). New York: Academic Press.

Goodman, N. (1968). Languages of art: An approach to a theory of symbols. Indianapolis: The Bobbs-Merrill Company.

Gregory, R. L. (1970). The intelligent eye. New York: McGraw-Hill.

Gregory, R. L. (1973). Eye and brain (2nd ed.). New York: McGraw-Hill.

Hagen, M. A. (1980a). Introduction: What then are pictures? In M. A. Hagen (Ed.). The perception of pictures: Vol. I Alberti's window: The projective model of pictorial information (pp. xxiii-xxvii). New York: Academic Press.

Hagen, M. A. (1980b). Generative theory: A perceptual theory of pictorial representation. In M. A. Hagen (Ed.). The perception of pictures: Vol. II Durer's devices: Beyond the projective model of pictures (pp. 3-46). New York: Academic Press.

Hurt, J. A. (1989). A guide for using visuals in teaching culturally diverse children. Tech Trends, (34)1, 24-26.

Kennedy, J. M. (1974). A psychology of picture perception. San Francisco: Jossey-Bass.

Keppel, G. (1982). Design and analysis: A researcher's handbook (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Kerlinger, F. N. (1986). Foundations of behavioral research (3rd ed.). New York: Holt, Rinehart and Winston.

Knowlton, J. Q. (1966). On the definition of "picture". AV Communication Review, 14, 157-183.

Lane, D. M. , & Pearson, D. (1982). The development of selective attention. Merrill-Palmer Quarterly, 28, 317-337.

Levie, W. H. (1987). Research on pictures: A guide to the literature. In D. M. Willows & H. A. Houghton (Eds.), The psychology of illustration: Vol. 1. Basic research (pp. 1-50). New York: Springer-Verlag.

Lorch, E. P., & Horn, D. G. (1986). Habituation of attention to irrelevant stimuli in elementary school children. Journal of Experimental Child Psychology, 41, 184-197.

Mackworth, N. H., & Bruner, J. S. (1970). How adults and children search and recognize pictures. Human Development, 13, 149-177.

Miller, L. K. (1978). Development of selective attention during visual search. Developmental Psychology, 14, 439-440.

Moray, N. (1970). Attention: Selective processes in vision and hearing. New York: Academic Press.

Murch, G. M. (1973). Visual and auditory perception. Indianapolis: Bobbs-Merrill Company.

Olson, R., Yonas, A., & Cooper, R. (1980). Development of pictorial perception. In M. A. Hagen (Ed.). The perception of pictures, Vol. II, Durer's devices: Beyond the projective model of pictures (pp. 155-192). New York: Academic Press.

Pick, A. D., Christy, M. D., & Frankel, G. (1972). A developmental study of visual selective attention. Journal of Experimental Child Psychology, 14, 165-175.

Pick, A. D., & Frankel, G. (1973). A study of strategies of visual attention in children. Developmental Psychology, 9, 348-357.

Pillsbury, W. B. (1973). Attention. New York: Arno Press.

Rosinski, R. R. (1977). The development of visual perception. Santa Monica, CA: Goodyear Publishing Company.

Rosonke, R. J. (1975). A study of the effectiveness of three visual attention-directing devices on the recall of relevant information from line drawings (Doctoral dissertation, University of Iowa, 1974). Dissertation Abstracts International, 35, 4316A.

Saettler, P. L. (1968). A history of instructional technology. New York: McGraw-Hill.

Saiet, R. A. (1979, March). Children's understanding of implied motion cues. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, New Orleans, LA.

Salomon, G. (1979). Interaction of media, cognition, and learning. San Francisco: Jossey-Bass.

Shepp, B. E., Barrett, S. E., & Kolbet, L. (1987). The development of selective attention: Holistic perception versus resource allocation. Journal of Experimental Child Psychology, 43, 159-180.

Sigel, I. E. (1978). The development of pictorial comprehension. In B. S. Randhawa & W. E. Coffman (Eds.). Visual learning, thinking, and communication (pp. 93-111). New York: Academic Press.

Sless, D. (1981). Learning and visual communication. New York: Wiley.

Smith, L. B. & Kemler, D. (1977). Developmental trends in free classification: Evidence for a new conceptualization of perceptual development. Journal of Experimental Child Psychology, 24, 279-298.

Smith, L. B., Kemler, D.G., & Aronfreed, J. (1975). Developmental trends in voluntary selective attention: Differential effects of source distinctness. Journal of Experimental Child Psychology, 20, 352-362.

Travers, R. M., & Alvarado, V. (1970). The design of pictures for teaching children in elementary school. AV Communication Review, 18(1), 47-64.

Tucker, D. J. (1985). A conceptual framework for studying interactions among symbols, visual imagery, and concept learning. (Doctoral Dissertation, Indiana University, 1984). Dissertation Abstracts International, 45, 3330A.

Winn, W. (1984). Why media? Instructional Innovator, 29(2), 31-32.

Winn, W. (1987, February). Are media merely vehicles for instruction? In M. R. Simonson (Chair), ...Mere Vehicles.... Symposium conducted at the Annual Convention of the Association for Educational Communications and Technology, Atlanta, GA.

BIOGRAPHICAL SKETCH

Elizabeth Downs was born in West Palm Beach, Florida, on April 14, 1953. She is the daughter of Francis F. and Bernice T. Downs.

She graduated from Cardinal Newman High School in West Palm Beach in 1971. From 1971 to 1973 she attended Palm Beach Junior College in West Palm Beach. In 1973 she received an Associate of Arts degree in music from Palm Beach Junior College.

Elizabeth moved to Tallahassee, Florida, in 1973. She graduated in 1975 from Florida State University with a Bachelor of Arts degree in elementary education.

After graduating from Florida State University, Elizabeth returned to Palm Beach County where she taught in the public school system for seven years. From 1976 until 1982 she taught at D. D. Eisenhower Elementary, which is an open concept school.

She returned to graduate school in 1982 and received her Master of Arts in educational psychology from the University of Florida in 1983. Elizabeth has taught several courses at the University of Florida including a course on instructional design and a course on instructional computing.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Lee J. Mullally

Lee J. Mullally, Chairman
Associate Professor of
Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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